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MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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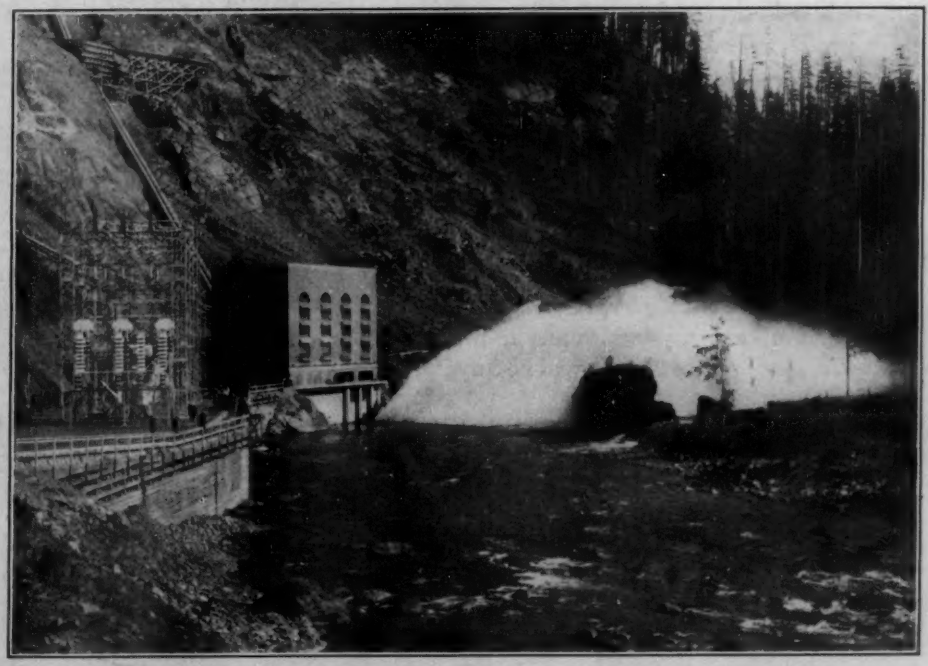

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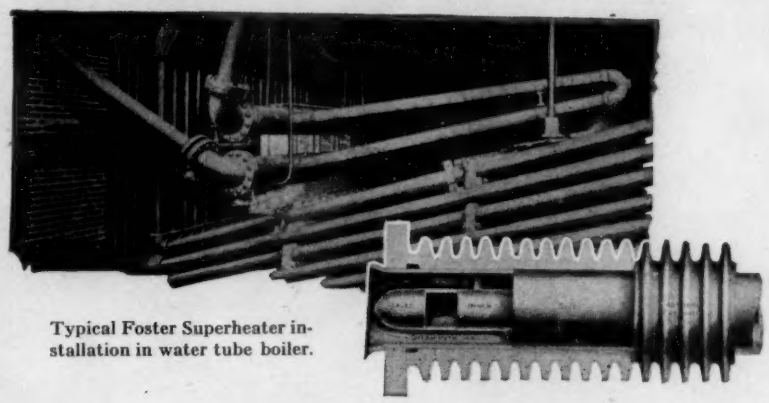

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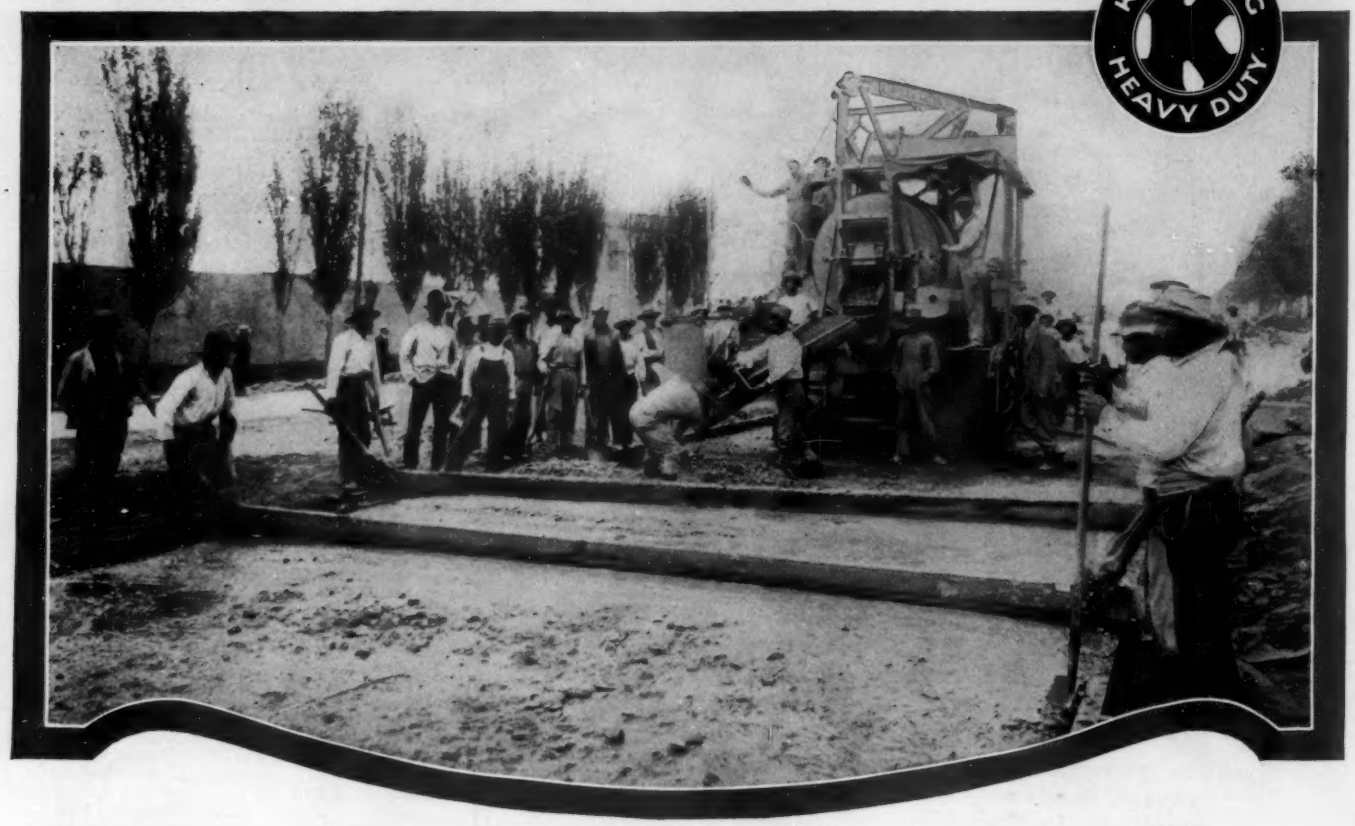

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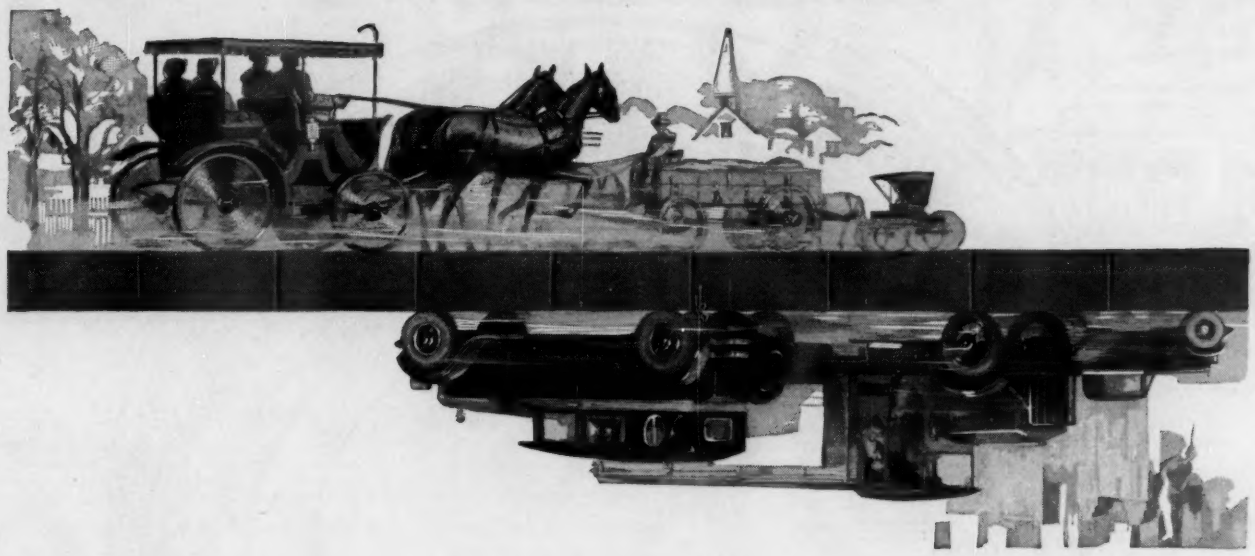

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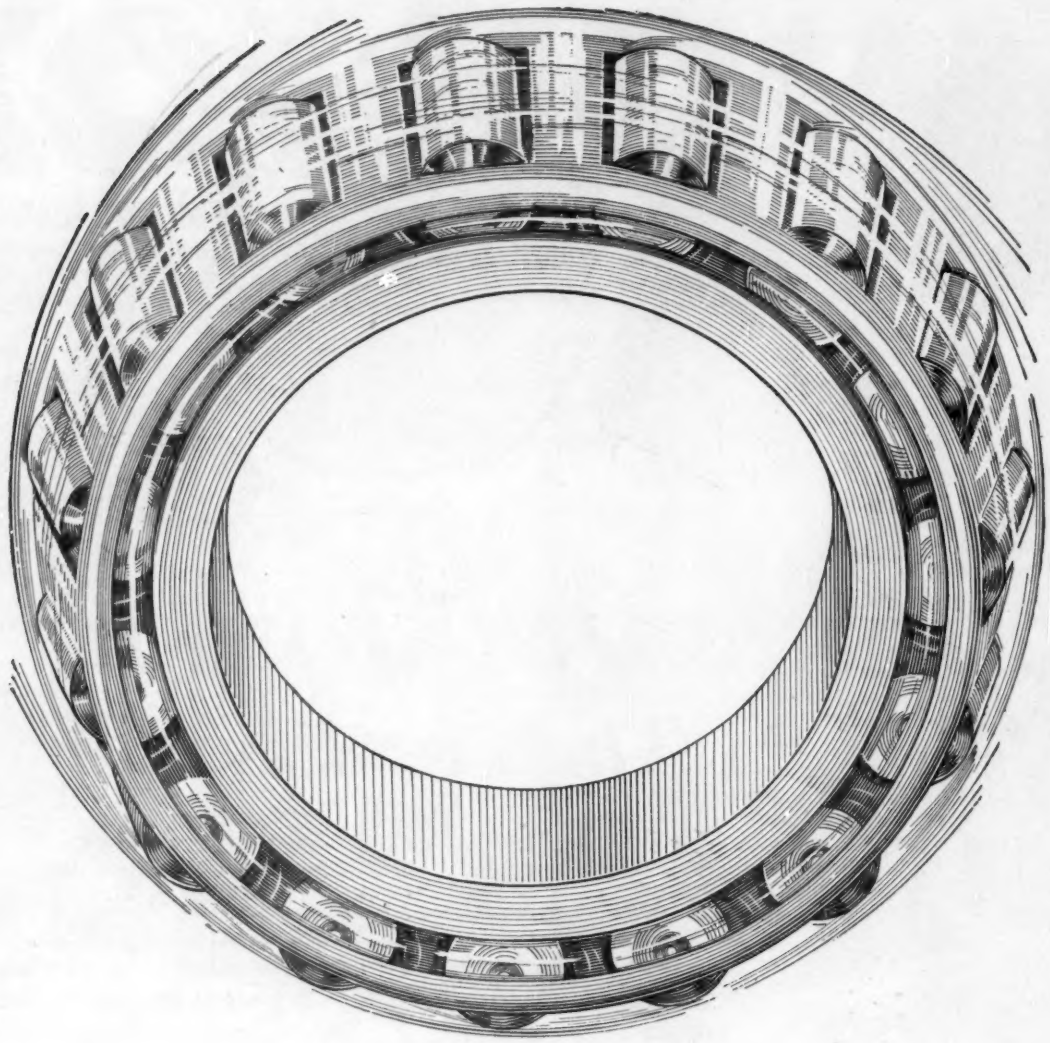

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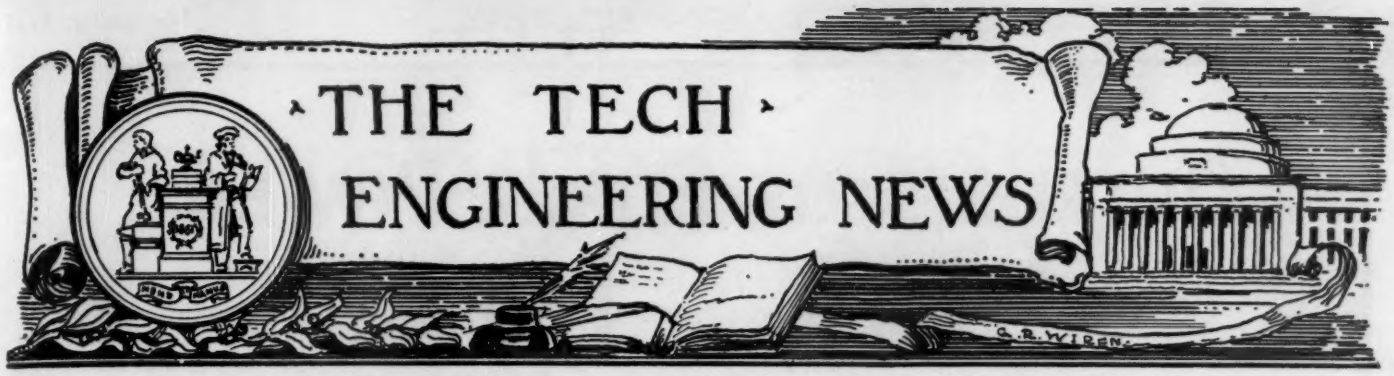

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OUTPOSTS OF SUPER-POWER

AT the left is the new Weymouth Station of the Boston Edison Company.

Below is the new Long Beach Station of the Southern California Edison Company of Los Angeles.

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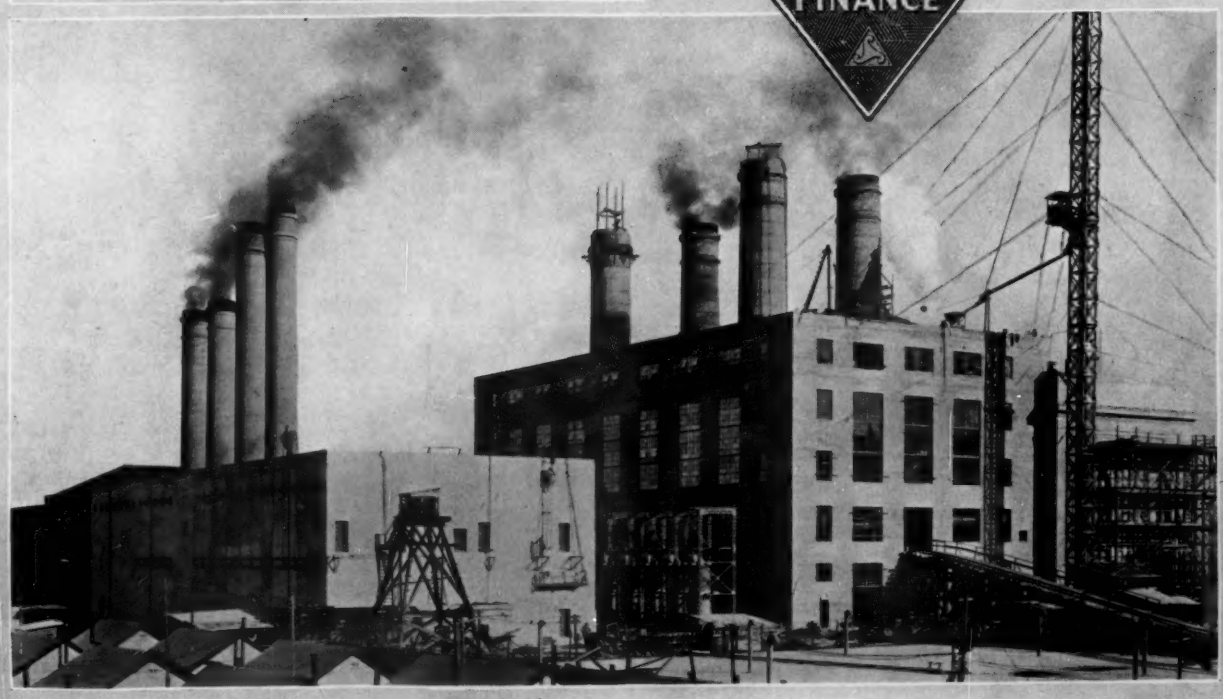

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME VI — NOVEMBER, 1925 — NUMBER 4

A Survey of Physics*

A discussion of the subject-matter of a collection of lectures and essays by Max Planck

By WM. S. FRANKLIN

Professor of Physics, Massachusetts Institute of Technology

INSTEAD of writing a more or less formal review of this book, it seems preferable to set forth its substance in a manner as simple and straightforward as possible so as to give the reader some help toward an understanding of the profound changes which modern researches have brought about in the fundamental ideas and theories of physics; and, of course, in a brief discussion of this subject, it is necessary to assume that the reader has considerable knowledge of classical physics, and that he knows something of the principle of relativity and a little of the quantum hypothesis.

The first really effective method to be employed in physics was the method of mechanics. This method was founded by Gallileo and Newton, and, as the method was developed, and more and more successfully applied, it came more and more to dominate the philosophy of physics, until, about the middle of the nineteenth century, the "mechanical conception," as Planck briefly calls it, was generally believed to be an adequate basis for the analysis of all the phenomena of nature; the "mechanical conception" aimed to explain everything in terms of motion; the "mechanical conception" is the view that all phenomena can be reduced to movements of particles or elements of mass.

The discovery of the principle of the conservation of energy (which was at first thought to be a purely mechanical principle) tended to strengthen the "mechanical conception," and the development of the kinetic theory of gases was looked upon as a sample of the unlimited conquests which the "mechanical conception" was destined to make. The latter part of the nineteenth century was the Golden Age of the "mechanical conception."

An interesting consequence of the complete dominance of the "mechanical conception" in the philosophy of physics during the latter part of the nineteenth century was a reaction against the widespread acceptance as ultimate realities of such mechanical pictures as those afforded by the kinetic theory of gases, and this reaction was most effectively voiced by Ernst Mach. There was no definite experimental knowledge of the atom fifty years ago; the atom was only an idea at that time, and the proud philosophy of the "mechanical conceptionists" drove many physicists back to a notion of reality as old as Greek philosophy; and some philosophers like Ernst Mach placed what seems to us now too great an emphasis on this old point of view, namely, the point of view that nothing is real but our sense perceptions, and that all science and all philosophy are an economic adaptation of our ideas to our perceptions, an adaptation growing out of our struggle for existence. This economic point of view can hardly explain a Newton or a Faraday, and Planck points out that it seems to be incompatible with the most important characteristic of the sciences, namely, the progressive attainment of a more and more general and unified point of view, which, while being kept in accord with experiment, becomes more and more nearly independent of the individuality of separate intellects, more and more nearly free from purely human bias, more and more nearly non-anthropomorphic.

Nevertheless the "mechanical conception" was a strong philosophy, and under its stimulus important scientific work was done and some results of permanent value obtained. Planck mentions the kinetic theory of gases as one of these valuable results. Indeed, the kinetic theory of gases is of very great value, although it is based on postulates which ascribe purely mechanical properties to the atom, whereas we have now renounced the purely mechanical conception of the atom.

The method of mechanics may be said to be still retained in modern physics and to be applicable to everything in nature where irreversible processes do not exist or where irreversible processes are neglected, and the method of mechanics thus widely used can be defined as including everything that conforms to and falls under the principle of least action; but the method of mechanics so defined, which Planck calls the method of dynamics, is by no means the same thing as the "mechanical conception," because in many cases it is independent of any knowledge of or any postulate concerning things or substances or particles which move. In particular, it includes in its realm such things as electromagnetic disturbances (light) without requiring the existence of the ether, and it is entirely in accord with the principle of relativity.

It is apparently absurd to speak of a method as a mechanical method or as dynamics (after Planck) when there is no thought of motion of concrete things, but at best only motion of energy (as in the case of light); but the method, in its mathematical aspects, in the kind of correlation which it accomplishes, and in the kinds of measurements involved in its experimental researches, is the same old method of mechanics.

The reader will be left, as it were, in a mental vacuum by the above reference to the principle of least action as the thing which characterizes the

(*Continued on page 164*)

*A review of the book entitled "A Survey of Physics," by R. Jones and D. H. Williams, 1925, E. P. Dutton & Company, New York.

Water Power Possibilities of the St. Lawrence and Niagara Rivers

A discussion of the technical, economical, and political aspects involved in the development of this six-million horsepower project

By H. B. DWIGHT

Professor of Electrical Engineering, Massachusetts Institute of Technology

THE St. Lawrence and Niagara Rivers have remarkable and practically unprecedented characteristics when viewed as sources of hydro-electric power. They have extremely large flow, which has very great uniformity throughout the year. They have a total drop of over 500 feet, which is concentrated in a few locations at large falls and rapids. Finally, these rivers are in a thickly settled and highly industrialized section of territory, and they are within transmission distance of a number of large cities.

In no case has the entire flow of these rivers been utilized for power development. This is contemplated, however, for the St. Lawrence River at Cornwall, where one rapid can give nearly as much power as all the developments using partial flow of these rivers so far constructed. If the entire flow should be developed wherever possible, new developments totaling probably 6,000,000 h. p. could be made. The discussion of such a huge amount of power may seem visionary and impractical, but while it is not likely to be developed in the next few years, yet from an engineering and economic point of view it ought to be developed. The chief obstacles seem to be the inherently large size of the undertakings, and the political questions, which are yet unsettled, about how to deal with or control these developments.

On the St. Lawrence, for some distance above Montreal, both banks of the river are Canadian territory. This part, which includes the Lachine and other rapids, can give as much as 1,400,000 h. p. of new developments, according to an estimate recently put out.

Farther up the river, the International Commission is busily engaged at the present time in preparing plans for a 1,600,000 h. p. development near Cornwall, half of this power to belong to each country. The fact that plans are being prepared shows a spirit of friendliness and co-operation between the two countries, but it does not mean that a decision has been made to go ahead with the project. However, this power development may be helped along because it is part of the St. Lawrence Deep Waterways Project to allow ocean ships to go up to the Great Lakes, for which there is a good deal of urgent demand from the districts farther west in both countries.

A very important item which should be kept in mind in discussing water-power projects is the estimated cost per horsepower of the installation. With water power this is much more important than operating costs. It is as essential as the price per ton would be in relation to a purchase of coal. It is, therefore, of importance that an approximate estimate of $115 per horsepower has been published for this project. This figure is low enough to compare favorably with other successful hydro-electric developments.

Turning our attention to the Niagara River, a question in which engineers and the general public have an interest and perhaps a duty to obtain the most correct information possible, is whether use should be made of the power of the Whirlpool Rapids. While these form a scenic spectacle, it would seem that it is not in the same class with Niagara Falls, and since there is available about 2,000,000 h. p., the development may be justifiable.

There is so much water to be handled in such a narrow space that there are technical difficulties in finding room for the water-wheel units and also for the overflow. Probably the only proposal that has been published for handling the entire river flow is that

Figure 1
TRANSMISSION DISTANCES

by Kennard Thomson, a civil engineer of New York City who was born and brought up near Niagara Falls. He has designed a dam 1000 feet long to be built on Foster's Flats, below the Whirlpool Rapids, where the Niagara Gorge is wider than usual. The spillway is at one end of the dam, and has the same width and location that the river now has.

The section of dam he proposes is interesting. The generators are inside the dam, and the water is fed to the water-wheels by a tubular passage in the dam, all the water being taken in at one end so as to avoid being choked with ice. The base of the dam is extremely broad, being 500 feet wide, so that the easy slopes will tend to prevent ice jams, or scouring of the river bed.

A very low cost per horsepower has been estimated for this development, and this does not seem impossible since the dam, which would be the largest item of cost, would be only 1000 feet long.

A description of a plan for a partial development has been published by which a tunnel several miles long would be cut through the rock in the side of the gorge and would feed a power-house at the foot of the rapids. Such a development would be of a conventional type, except that the tunnel would be unusually long and expensive. Such a partial development could give only a few hundred thousand horsepower out of two million available.

The final location to be considered is at Niagara Falls. It is practically a unanimous opinion that Niagara Falls should be kept unimpaired as a scenic spectacle.

Niagara Falls are at present at a very fortunate stage as regards scenic effect, since they form a circular panorama of great extent and beauty. About five hundred years ago, when the Falls went straight across the Gorge, where the arch bridge now is, the spectacle was not nearly as fine as at present. In the future, when the Horseshoe Falls will have turned the corner and got behind Goat Island, the spectacle will cease to be the panorama which we now see. The wearing back of the Horseshoe Falls should, therefore, be delayed as much as possible.

The map shown in Figure 2 gives the surveyed location of the Horseshoe Falls for 1764 and 1842, and it plainly indicates that the maximum wear is at the narrow central cleft where the greater part of the flow of the river is concentrated. This wear is about six feet per year. The excessive concentration of water in the central cleft is detrimental in causing rapid wear of that part, and in taking water away from other parts of the Falls. For instance, the American Falls, which are 1000 feet wide, have only 1/20 of the total river flow. It therefore appears to be the duty of the American and Canadian governments to build submerged dams above the Falls to deflect water away from the central cleft and minimize its objectionable effects.

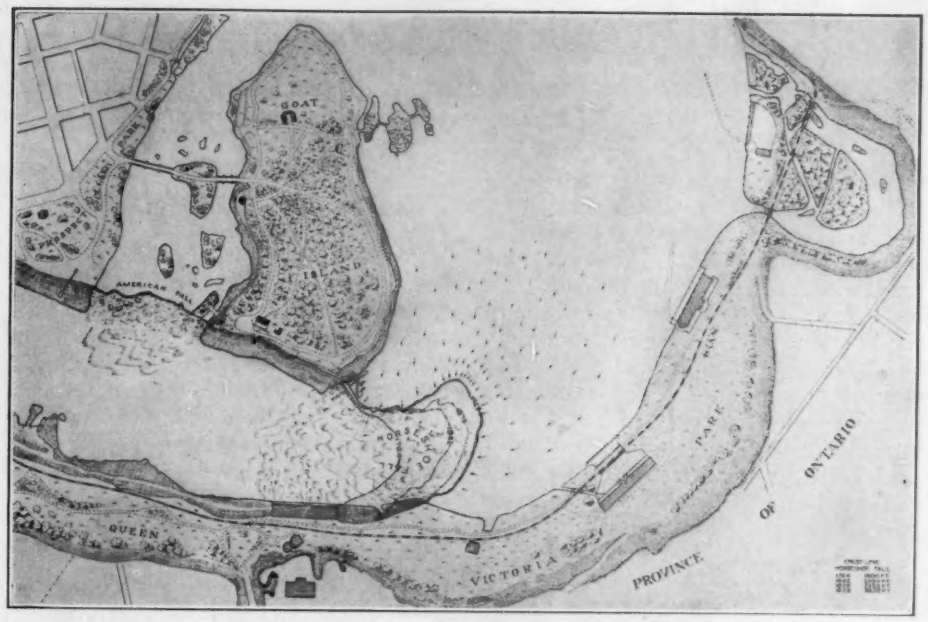


Figure 2

A DIAGRAMMATIC SKETCH OF NIAGARA FALLS

The location of the crest of the Horseshoe Falls is shown as it existed in various years from 1764 to 1923. The progress toward the destruction of the horseshoe form of the fall is well illustrated.

An international treaty limits the amount of water for power development at Niagara Falls, in order that their scenic value shall not be impaired. By building dams above the Falls, it is possible to spread the water so as to improve the scenic effect, and further, to allow increased water for power. It is therefore possible to revise the treaty so as to allow greater power generation without departing from the original purpose of the treaty. Water should not be allowed to run to waste and serve no purpose either of scenic effect or power generation.

The effect which submerged dams or artificial islands above the Falls would produce has been experimentally determined by the 100-foot, outdoor model of Niagara Falls which was described and illustrated in THE TECH ENGINEERING NEWS of May, 1925, by E. H. Sargent, Chief Engineer of the Hudson River Regulating District. Experiments with the model indicate that an additional 1,000,000 h. p. or more could be developed at the Falls, without bad effects, and with actual benefit to the Falls.

New power developments at Niagara Falls could be made, if the treaty were revised, by enlarging or duplicating any of the present developments on both sides of the river. It has also been proposed by Kennard Thomson that tunnels be cut under Goat Island, supplying a power-house built into the base of the cliff. This would seem not to interfere with the use of the island for park purposes in any way.

One-half of the total water would belong to Canada, but if developments on the American side prove to have a lower cost per horsepower, there does not seem to be any reason why locations in American territory should not be leased to Canada, and all the rights of both countries thoroughly safeguarded.

A great deal of ice passes down the Niagara River in the winter and spring, and it reduces the output of the different plants at times. Ice collects at the eastern end of Lake Erie for several miles, and lasts sometimes till the middle of May. It appears possible to construct a dam across the Niagara River at the Lake Erie end to hold back the ice until it melts in the spring. Such a dam would have to be suitably protected by breakwaters so that storms would not force the ice over the dam. A small ice-breaker could be put in operation, so that the opening of navigation would not be delayed by reason of the dam. The crops in the district surrounding that part of Lake Erie would not be delayed much by the dam, for in May the weather is warm enough to melt the ice in a few days, even if the ice does not pass down the Niagara River.

The control gates of such a dam near Buffalo could be operated to give seasonal storage of water. The level of

(*Continued on page 160*)

World's Highest Head Reaction Turbine Plant

A description of the 860-foot head Oak Grove Station of the Portland Electric Power Company, including a discussion of reasons for the development

By Wm. Benjamin West, '20

Mgr., Engineering View Company, New York, N. Y.

In general, reaction turbines are used where a stream has a low head and impulse turbines are used where a stream furnishes a head of several hundred feet. However, one notable departure from this practice is the case of the Oak Grove Station of the Portland Electric Power Company, the head of which is 860 feet. The story of how this development came to be made with reaction turbines is an interesting one not only to hydraulic engineers, but to electrical and mechanical engineers and other people in the various branches of engineering work.

History

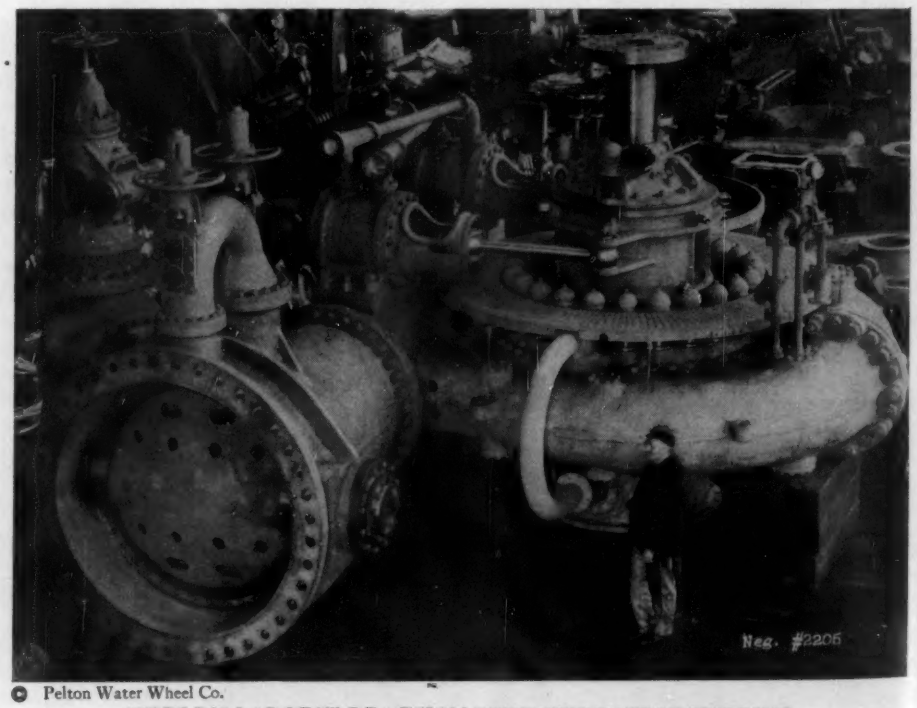
The first turbines installed in the western country were of primitive construction, built from designs that were developed largely by cut-and-try methods, for installation under comparatively low heads. Impulse turbines or Pelton wheels (named after Lester Pelton, an old miner and millwright who is credited with the invention of the first split bucket, which, in a more improved form, is still used in modern equipment) were used almost exclusively in the Pacific Country, in the large and more important installations, until about fifteen years ago. At this time the growing paucity of accessible high-head sites for Pelton-wheel installations caused engineers to turn somewhat to the possible development of somewhat lower heads by use of Francis turbines. A number of such turbine installations were made of a capacity considerably exceeding earlier designs, and thus constituted an early advance in the art of turbine development in the great West. Numerous plants were installed for heads lower and water quantities larger than were suited to Pelton wheels, and economic conditions were responsible for leaving these sites, offering the combination of high head with large water quantity in a largely undeveloped condition.

As a result of the growth of industry and increasing demand for power, there naturally followed a consolidation of the smaller companies into operating systems of considerable magnitude and greatly enlarged resources, and these systems were often co-ordinated with others, thus effecting further economy in operation and investment. The public-utility companies formed by such consolidations were able to look upon the power problem and the development of added capacity to meet the existing and growing demands from a far different and more comprehensive viewpoint than had been possible in the earlier days of hydro-electric construction.

The World War and its demand for conservation of resources led to further interconnection of the large companies, forming a network linking together and thus co-ordinating practically all of the water-producing sources on the Pacific Coast. It can be well understood, under such circumstances and with such background, that the best engineering thought led toward a more comprehensive development of the entire watersheds, with their rivers and tributaries, into single projects. The increased resources of the power companies, and their superior ability to finance projects of greater cost, made it possible to turn again to those power sites the development of which in the earlier days had been beyond the means available. The fact that such projects were generally more remote from the market no longer presented an insurmountable barrier, for long transmission lines and the use of higher transmission voltages eliminated this difficulty.

However, with the advent of the long transmission lines, it became necessary to give consideration to other factors in the design of hydro-electric machinery. It followed logically that the future power-house should contain units of such capacity that a single one would be able to charge a transmission line of great length. The growth of the power demand, supplied by the larger companies, made it necessary to consider individual units of large capacity which would operate continuously upon a block or base load and at efficiencies which would insure the most economical use of the water supply. It followed logically that water-wheels of the Pelton type, of capacity sufficient to meet the general operating requirements, would be found unsatisfactorily large and of relatively slow speed if used under some of the heads that were available for development. Economically, therefore, the Francis turbine offered a very attractive possible solution for such installations, provided it could be made dependable and its operation and maintenance under heads hitherto untried could be successfully demonstrated. Such were the conditions that made the selection of a reaction turbine for the Oak Grove Station possible. It was too large a volume of water to be economically handled by Pelton water-wheels of the impulse type.

The first distinctly high-head Francis-type turbine design was developed for installation at the Kern River No. 3 Power-House of the Southern California Edison Company. This plant uses the water of the Kern River, and



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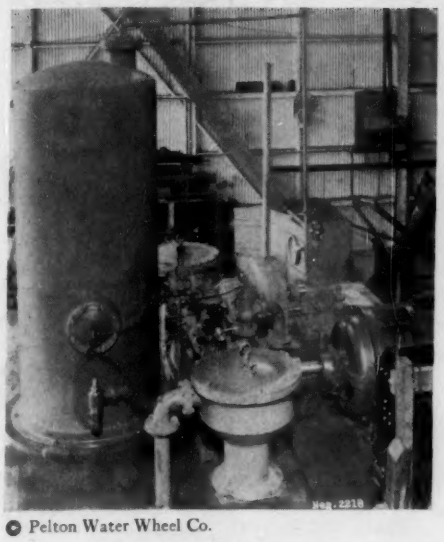
WORLD'S LARGEST REACTION TYPE HYDRAULIC TURBINE

The turbine is 35,000 horsepower and is now in operation at the Oak Grove Station.



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OIL-PRESSURE SYSTEM
This system is for the hydraulic turbine governors.

consists of two 25,000 h. p. vertical Pelton turbines of the Francis type, operating with a head of 810 feet, and with speeds of 500 or 600 r. p. m., depending upon whether the plant is connected to the 50-cycle or 60-cycle portion of the Edison Company System. The Oak Grove Plant of the Portland Electric Power Company, which went into operation in July, 1924, is the second of the high-head installations, and so far as known is the highest-head plant in existence in which reaction turbines are the main source of power.

Description of the Plant

The Portland Electric Power Company has for many years supplied electric power to the industries in Oregon and has participated in the evolution of hydro-electric plant design and operation as have few others in the Western States. There is in service on its system at the present time a series of low-head reaction turbines installed in 1889 to operate under heads of from 20 to 40 feet, each unit driving a generator of 425 kw. capacity. In 1907 a turbine was installed for operation under 130 feet head and direct connected to a 2500 kw. generator. Later, in 1911, a third installation was made, utilizing a number of turbines operating under 81 feet head and each direct-connected to a 3300 kw. generator. A year later, in 1912, a further development was made utilizing a head of 325 feet and a generator of 5250 kw. capacity. It can be seen, therefore, that the Portland Electric Power Company has participated in the growth of the hydro-electric industry over a considerable period of years, during which the operating head for turbines on their system has changed from 20 feet in 1889 to 860 feet in 1924, while capacities per unit have gone from 425 kw. to 25,000 kw. During the same period the system has grown until now it has a capacity of about 90,000 kw., serving a population of 350,000 people distributed over a total area of 500 square miles. This undertaking requires 550 miles of high-tension transmission lines and over 9200 miles of distribution lines, the present yearly output being over 350,000,000 kw. hrs. Here can be seen the typical development and conditions responsible for the present-day large-capacity hydro-electric units.

The Oak Grove Plant is situated on Oak Grove Creek, a tributary of the Clackamas River, about seventy miles from Portland, Ore. The stream flow of Oak Grove Creek is very uniform and dependable in dry seasons. Water is diverted about six and one-half miles above the plant by a concrete intake dam of arched form 68 feet high and 68 feet long. The first 1500 feet of the conduit from the dam is a concrete lined tunnel 14 feet in diameter, this section being designed of sufficient capacity for carrying water for the full development, which ultimately will consist of three 35,000 h. p. turbines. A nine-foot-diameter steel pipe continues from this point to a concrete Johnson differential surge tank at the crest of the hill, from which the principal drop to the power-house is secured. A wye, or manifold branch, is also provided at the lower end of the 14-foot-diameter tunnel section for the connection of future pipe-line conduit which will be installed when the additional units are put in. A penstock proceeds from the surge tank to the power-house a distance of 1200 feet, tapering from a diameter of 8 feet at the top to 6 feet at the bottom, where the turbine is connected with a static head of 930 feet. Between the outlet to the surge tank and the upper section of the penstock a Johnson valve is installed.

The power-house at the present time contains one 35,000 h. p. vertical Pelton turbine designed to operate under an effective head of 860 feet, and driving a General Electric generator of 30,000 kva. capacity, wound for 11,000 volts at 514 r. p. m. A direct-connected exciter is mounted on the upper end of the generator, and the rotating element, consisting of generator, rotor, and turbine runner, with their respective shafts, is supported by a Kingsbury thrust bearing. The generator is ventilated by means of closed air ducts which surround it, and air circulation is induced by rotation of the machine itself. Provision is made for forced ventilation if it is later required.

As previously stated, the turbine is of the vertical type. Its shaft is rigid-coupling-connected to that of the generator above, there being in all three steady bearing supports for the entire shaft length. Two of these are incorporated in the generator and the third is in the turbine. The runners are mounted upon a tapered portion of the shaft which extends below the turbine bearing. The main floor of the power-house is located at the upper level of the generator. The governor and the control for the main shut-off gate are located on this operating floor, and suitable extensions are continued downward to the turbine-operating deck two stories below. Still further below the turbine-operating deck is the draft-tube deck, from which access is had into the turbine casing by removal of certain of the draft-tube sections, which are made of metal and especially designed for the purpose. The draft tube is of the Moody spreading type, formed in the solid concrete substructure of the power-house. The turbine casing is made of annealed cast steel in several sections, heavily bolted together with high-pressure gaskets. Extension pads are provided on the casing sections for the support of the servo-motor cylinders. The upper and lower ring covers for the turbine casing are made of cast iron, and both have bronze-fitted bearings for supporting the turbine guide-vanes.

The runner is a single bronze casting having a capacity of 35,000 h. p. at an effective head of 850 feet. The normal operating speed is 514 r. p. m., and the specific speed (English system) is 21.5. Turbines designed for lower heads use no stuffing-boxes at the point where the shaft passes from the interior of the casing, a grease seal being normally considered ample protection. Obviously, however, should any internal

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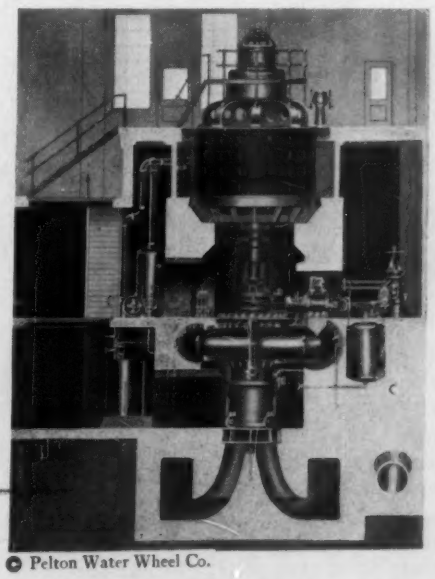

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CROSS SECTION OF REACTION TURBINE
The relief valve, which functions when the power is thrown off the station, is shown in the right-hand corner.

Launching of the U. S. S. Lexington

An account of the considerations in the launching at the Fore River Plant, including a description of the airplane carrier

By HENRY H. W. KEITH, '05

Associate Professor of Naval Architecture, Massachusetts Institute of Technology

THE United States Airplane Carrier *Lexington* was launched at the Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd., at Quincy, Mass., on the third of October. The launching of this ship was of unusual interest, not only to naval architects and others familiar with the problems of launching, but to everyone who was there to witness it.

In addition to the great size of the vessel, there was the unusual feature of stopping her almost as soon as she was afloat. When it is realized that the weight of the ship and her cradle during launching was something over 27,000 tons, the greatest ever attempted in this country, and that this weight was moving over twenty feet per second when the vessel left the ways, it will be evident that the stopping of the ship with her bow less than 140 feet from the end of the launching ways was an achievement of the greatest magnitude.

Furthermore, it must be realized that the checking arrangements could not be brought into action too soon, for then the vessel might stop before being entirely clear of the ways. In other words, the checking arrangements had to function in the very short distance of about 200 feet, or in less than a quarter of the length of the ship. The entire success of the undertaking therefore reflects great credit upon the builders of the vessel, and shows the extreme care and forethought which were given by them to the launching arrangements.

The *Lexington* is an unusually interesting ship, and when completed will form a most valuable and needed addition to the United States Navy. With her sister-ship, the *Saratoga*, launched at the shipyard of the New York Shipbuilding Company, at Camden, N. J., last April, the Navy will have two of the largest and most up-to-date airplane carriers in existence, and in view of the increasing importance of aircraft, a long-felt want will be supplied.

The present *Lexington* is the fourth vessel of the United States Navy to bear this historical name. The first was a brig, carrying 16 guns, and authorized by Congress in 1775. She took an active part in the Revolutionary War, but was finally captured by the British ship *Alert* in 1777. The second vessel of this name was a sloop-of-war, built in 1825, later serving in the Mexican War, while the third *Lexington*, a side-wheel steamer, rendered valuable service during the Civil War on the western rivers.

The new *Lexington*, and her sister-ship, *Saratoga*, are the longest warships ever built, and the largest ships of any kind ever built in this country. They, with four others of the same design, were originally intended as battle cruisers, and were authorized by Congress in 1916. In 1922, under the terms of the Washington Disarmament Conference, four of these ships were doomed to be scrapped, while the *Lexington* and *Saratoga* were redesigned as airplane carriers.

The *Lexington* has a length over all of 888 feet, a breadth of 106 feet, and will have sufficient power to make a speed of 33 knots, or about 38 miles, an hour. In addition to being able to carry over 70 airplanes, the *Lexington* carries a battery of eight eight-inch guns, and twelve five-inch anti-aircraft guns. Her machinery is capable of developing 180,000 horsepower, and consists of four turbo-generator sets which supply electricity to eight motors, these latter being connected in pairs to each of the four propeller shafts. Each motor has a capacity of 22,500 horsepower, a weight of over 200,000 pounds, and is 15 feet in diameter. An idea of the size of this immense power plant can be obtained from the published statement that if moored to a pier the *Lexington* could generate sufficient electricity to supply the needs of the city of Boston. The power of the *Lexington* is also over six times that of the new United States Battleship *Maryland*.

When completed, the *Lexington* will present a most unusual appearance, as the uppermost deck, extending completely from bow to stern, has been designed as a landing platform for airplanes. In order that these may have a wide, clear run-all fore-and-aft, the superstructure, smokestack, bridges, mast, etc., are to be placed on the starboard side. Completed, the *Lexington* will cost about $43,000,000.

As previously stated, the *Lexington* had a launching weight of over 27,000 tons. In order to check the momentum of this immense moving weight, twenty drags, made up of piles of chain cable, were used. These drags were attached to the ship's side by wire ropes, eight inches in circumference, and the total weight of the

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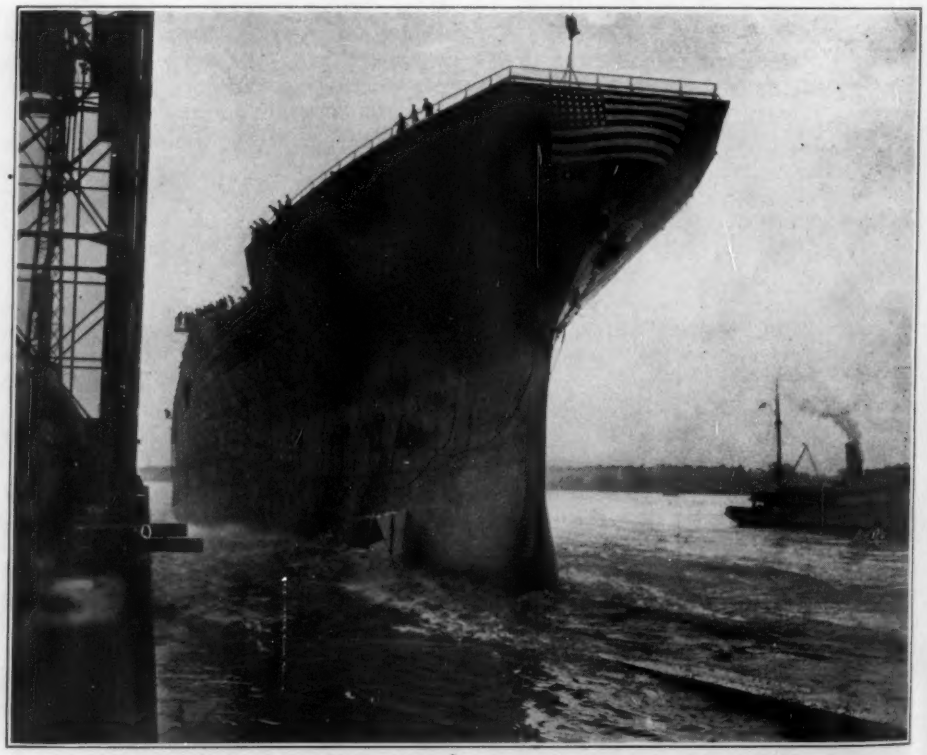


© *Boston Herald*. Photo by Ernest C. Hill

THE U. S. S. LEXINGTON BEING LAUNCHED AT FORE RIVER

This new ship can carry about 70 planes on her deck. She will have a speed of 33 knots and will carry 12 five-inch anti-aircraft guns.

Enameling—An Important Branch of Ceramics

A description of the process, fundamentals, and problems incurred in enameling on cast iron, sheet iron, and steel

By MILES M. ZOLLER, '21
Eagle Picher Lead Company, Chicago, Ill.

THAT branch of science known as Ceramics is broad in its scope and includes such important industries as pottery, glass, enamelware, terra cotta, and clay products. An endeavor will be made here to describe briefly the terms, history, processes, fundamentals, and difficulties incurred in one branch of the ceramic art, namely, that of enameling on cast iron, sheet iron, and steel.

Enameling of this type is called vitreous, and the glasses applied to the metal are opaque. The term "porcelain" is used in the trade to cover the pottery division. Here the body is a clay base instead of metal, and the glass covering is called a glaze instead of an enamel. The glaze is not necessarily opaque, depending on the type of body that it has to cover.

Before going too far into the enameling problem, it might be interesting to trace the development of ceramics from early times up to the present day. In H. G. Wells' "Outline of History," the first mention of pottery or unglazed earthenware shapes dates back ten or twelve thousand years B. C., or during the Neolithic Age. Inscriptions on pots, jars, and so forth have enabled historians to obtain accurate data on the life, habits, and customs of people who lived so many thousands of years ago. It is interesting that, instead of depending on history for information regarding pottery, history has been more or less dependent on pottery. The first stage of pottery was when man made shapes out of wet clay and allowed them to dry in the sun. This proved highly unsatisfactory, for as soon as rain or water touched the piece, it was again reduced to mud. The discovery was next made that fire treatment overcame this difficulty; but with the temperature that primitive man was able to obtain, the articles were still porous. About 4000 B. C. the Egyptians discovered the use of glaze, probably coincidently with the discovery of glass; however, the Chinese are considered the greatest potters, and the first lead glaze was no doubt made by them several centuries B. C.

The derivation of some of the present-day terms used in the ceramic art is very interesting. The word "ceramic" comes from the Greek word meaning "earthen" or "earthenware." This narrow meaning has, of course, expanded to take in many allied arts and industries. The term "porcelain" developed in a peculiar manner. The Chinese exported some of their very fine ware to Italy, and the Italians likened its luster and beauty to the sea-shell, "*porcellanus*," the shell being so called on account of its shape being similar to that of the back of a pig. The Latin term for this animal is "*porcas*." Oddly enough, then, the name for this beautiful type of pottery was derived from the lowly pig.

Time has brought wonderful developments not only in the pottery end of ceramics, but also in the enameling end. Although this latter art has been known for many years, it is not until lately that the iron and steel enameling industry has become of commercial importance; in fact, the last twenty years have seen its wonderful development. This has been due largely to the general advancement of science. Able chemists and ceramists have done much toward this development, and have succeeded in bringing to light trade secrets that heretofore had been closely guarded by a few. As a consequence, the ceramic industry has gone steadily ahead, and today the most accurate figures obtainable show that in value of products produced it is second only to the great steel and iron industry. The demand and consumption of ceramic products have steadily increased the past few years, and the possibility of still larger production and expansion in the future is practically an assured fact.

The accompanying chart shows the processes required to produce a finished piece of enameled ware. In the brackets to the right of the center line is shown the outline for the dry process — cast-iron enameling. The brackets to the left outline the wet process — sheet steel or sheet iron enameling. The brackets in the middle indicate processes used by both types.

The first stage is the mixing of the raw materials for the enamels. There are three types of raw materials — refractories, fluxes, and opacifiers. The refractories are the materials that fuse at a high point; the fluxes are the ones that fuse at a low point, and the opacifiers are the ones that give the opacity to the enamel.

The four usual refractories are feldspar, quartz or sand, cullet or broken glass, and clays. Clays, however, are not generally used in the frit. Common fluxes are calcium carbonate, barium carbonate, soda ash, sodium nitrate, litharge, red lead, zinc oxide, and borax.

The fluorides are considered accessory opacifiers, because they give some opacity to the enamel, but not enough. Tin oxide is the main opacifier used today. Other opacifiers are the antimony compounds, either antimony oxide or sodium met-antimonate; zirconium oxide or silicate, and arsenic oxide. The latter is not used generally on account of its poisonous nature.

Sometimes these raw materials are mixed in rotary mixers and at other times they are mixed with a shovel. They are then put in a furnace called the frit furnace or frit smelter, which reaches a temperature of about 2400° F. That temperature is high enough to drive off the water in the borax and the gases in the barium carbonate and calcium carbonate. After the mix has been completely fused, and all the gases driven off, it is then run into a tank of water, where the molten mass of enamel solidifies and breaks up. For wet process work, the enamel or frit is dried for the purpose of getting accurate weight, so that the exact percentage of water will be known. It is important to have these figures to control the viscosity of the mixture. In the wet process the enamel is ground in water.

The enamel is suspended in water for ground coat application in either of the two processes. The coat is then applied to the base metal by slushing, that is, by dipping the piece in the suspension and shaking to get uniform distribution, or by draining or spraying. Sometimes the ground coat is applied with a brush in the same manner as paint.

After the wet ground coat has been applied, it must be dried before being put into the enamel furnace, otherwise the water would blister the enamel and throw it off. In the wet process, the cover coats are then applied and dried and succeedingly fused onto the metal, in the enamel furnace.

In the dry process, after the under coat has been fused on the casting, the cover enamel is sifted on dry and the piece put into the furnace. It is then cooled and another coat applied until finally the piece of ware is finished.

Some of the articles produced by the wet and dry processes are listed at the top of the chart.

Another process is that of applying the enamel wet to cast iron, a process which is adapted to small castings where production is a big factor. Here lead oxide is used more extensively than in any other process.

The chart also indicates a typical

dry and wet process formula showing the percentage of various ingredients. In the wet process the frit is made without an opacifier. After smelting, tin oxide is usually added to the frit, which is then ground and mixed with water. Clay is also added to the mixture as a suspending agent to obtain proper dispersion.

The theory of opacifiers in enamel is similar to one with which we are all familiar, viz., pigments in paints. Contrary to popular belief, opacifiers in enamels are not truly opaque, for when viewed under a powerful microscope they are all transparent. Therefore, they do not make enamels opaque by forming suspensions of opaque material. Simply, the theory is that the opacifiers, having a higher index of refraction than the material in which they are suspended, together with their insolubility and fine state of subdivision, diffuse light in so many directions and angles that the enamel becomes opaque and white.

As stated before, tin oxide is probably the most widely used opacifier. Different grades of tin oxide give varying results as to the color of the enamel. Enamels high in sodium or potassium tend to decrease opacity, as there is a tendency toward soluble sodium or potassium stannates being formed. Three per cent of tin oxide usually goes into solution in the frit. Enamels having lead as a flux and tin as an opacifier give fine white coatings.

The price of antimony oxide is less than half that of tin, and is being used considerably at the present time. There are three oxides of antimony, viz., tri, tetra, and penta. All pass to the tetra oxide when heated. About five per cent of the oxide goes into solution when fritted. Antimony cannot be used successfully for producing white enamels where the formula calls for more than ten per cent lead oxide. More lead than that amount will result in a yellow color. Here, too, the calcium content has to be controlled in order to keep away from blue tints, developed when antimony and calcium are used in the same enamel. Some theories have been propounded claiming that the yellow tint produced with lead tends to neutralize the blue color from antimony and calcium, thereby producing a white or greenish tint. The mechanics of such discolorizations are not completely understood, and in view of the fact that they do not uniformly occur where antimony is used in conjunction with calcium, it is safe to say that the nature of the atmosphere in the frit furnace has more to do with the trouble than anything else.

It is very easy to get reducing conditions in the furnace if the smelter is not watched closely. Quite a few manufacturers claim that they have less trouble with color when the poorer or impurer grades of antimony oxide are used. Sodium met-antimonate is now being used as an opacifier. This product assures the manufacturer of having the antimony in its highest state of oxidation, and of greater uniformity.

Zirconium oxide of silicate is being used sparingly in place of tin or antimony. A greater amount of zirconium opacifier has to be used than tin to get equal opacity. The resultant enamel does not have as good color, and because zirconium compounds are more refractive, more fluxes or higher heats must be used. The former runs up cost and the latter diminishes the value of the opacifier by putting more in solution. When zirconium is used in the mill, fairly good results are obtained. The economy of using zirconium products has certainly not yet been established in the minds of plant men, and when good results are desired they always fall back on tin oxide.

It seems advisable to tell briefly how formulas are developed. Cast iron has a coefficient of expansion or contraction of about 310 x 10–6, and steel around 400 x 10–6. The expansion coefficient of the raw materials used in enamels has also been calculated so that by multiplying the percentage of the ingredients in the melted weight by those figures, and adding, the coefficient of expansion of the resultant enamel can be obtained. The ideal enamel, of course, would have the same figure as that of the base metal, and as far as practicable this is done. Lead oxide is the only one that approximates the coefficient of contraction of iron. In other words, if we had a glass consisting of 100 per cent lead oxide, it would have a coefficient of 300, which is practically ideal because it is about the same as that of iron.

Other important factors, however, must be taken into consideration, such as:

1. Permanency of the enamel. The more silica, the more permanent and acid-resisting the enamel; however, this cannot be carried too far, due to silica's low coefficient of expansion.

2. Heat necessary to melt enamel. For example, the higher the silica, the greater the temperature of fusion. SiO_2 melts around 3000° F. If the silicate content is high, higher heat for fusion would be necessary, and this naturally increases manufacturing costs.

3. Tendency of certain fluxes to crystallize out of solution when used in too large quantities. This occurs in the same way that salt crystallizes out of a salt-water solution when cooled. Crystallization naturally weakens the enamel and causes a dull or greasy appearance.

There are many other important factors that must be juggled to obtain a practical enamel, but for the sake of space they cannot be taken up here.

The common trouble experienced with enamels is crazing and chipping. Crazing is the reverse of chipping. Both of these occur on account of some stress being set up in the solidified enamel. One of the reasons might be due to difference in coefficient of expansion.

Of course, when the enamel is in the molten form there is no stress and no chance of crazing or chipping, but if after solidifying the entire enamel has a coefficient of contraction or expansion considerably less than that of iron, chipping will probably occur. In other words, the iron will contract more than the enamel. Of course, the enamel shapes itself to the iron, and thus it can be seen how compression stresses are set up.

Crazing is just the opposite — the enamel is higher in its coefficient of contraction than the base metal. Little hair lines will show up in the enamel when that condition exists, as the stresses are in the opposite direction.

Secondly, when cast iron is heated above 1200° F., there is a permanent expansion or growth, due primarily to the oxidation of elemental silicon to oxide, the silica per cent determining the amount of growth. Also, iron may be oxidized and possibly carbon changed to graphite. When annealed iron is enameled, therefore, contraction on cooling is lessened by the growth. Variation of the silica content in the iron without corresponding change in enamel formulation would, therefore, tend to cause either crazing or chipping.

Thirdly, crystallization caused by using excess of some component sets up stresses that result in crazing or chipping. The stress would occur between the crystal and the homogeneous enamel. Crystallization is hard to see in opaque enamels as the opacifier ordinarily hides the crystal.

Fourthly, inequality of temperature in cooling sets up stress. If the coating is thicker in one spot than in another, there are bound to be forces exerting themselves between the part that is thinner and cools quickly and the part that is thicker and cools more slowly. To overcome this, the piece should be removed from the furnace, allowed to cool somewhat, and then returned. This tends to equalize the temperature at different spots.

Fifthly, external force, such as a blow, may cause crazing or chipping, as the strength of the enamel may not

(*Continued on page 168*)

The Parsons Line

Its application to power plant management as a basis for calculating bonus systems

By F. JOHNSTONE TAYLOR
Major, British Army, Retired

A GOOD deal has appeared in technical journals of late as to the "Parsons line," but a lucid explanation thereof, such as would interest the average operating engineer, is lacking.

The term is merely an arbitrary one given to a certain form of chart, the purpose of which is to record graphically the working-conditions of a plant during some definite period with which the working at any other period may conveniently be compared.

It was introduced some few years back by a Mr. R. H. Parsons. It shows the coal burned by or the water fed to the boilers on the basis of kw. hours generated. There is, of course, a marked variation thereof as the output varies, while with no useful load at all the boilers must still stand by and there is still some coal and water being

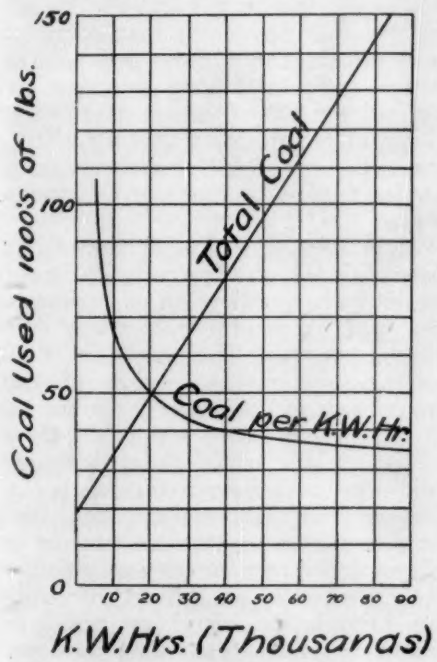


Figure 1

consumed. Moreover, even when the station plant is working at full power, the "no-load" loss remains a constant factor in the total coal consumption.

Now if on squared paper the kw. hours are set up as abscissæ, and all the obtainable coal consumption figures for different outputs as ordinates, the dots representing the latter tend, as shown in the accompanying diagrams, to collect themselves in a narrow area, through which a mean straight line can easily be drawn. The same process may be extended for water consumption. In both cases the straight, sloping line cuts the zero ordinate at some distance above zero point, showing that, even when no useful current is being generated, a certain amount of coal has still to be burned.

It is the usual practice to make out these charts in thousands of pounds of coal and thousands of kw. hours per shift. The Parsons line, then, represents average coal consumption of the plant at all outputs, and by marking on the diagram at the end of each shift the quantity of coal burned for the number of kw. hours generated, it can be at once seen whether the working of that particular shift is above or below average. The line has proved of considerable value in enabling power-station superintendents to see at a glance the coal consumption per unit for each shift. The use of such diagrams has had a marked effect in improving the efficiency of plants where it has been used; it is now in extensive use, and although there has been diversity of opinion as to its scientific accuracy its value in practice has not been seriously challenged. In fact, it is so simple that there is little or no scope for question except as to the correct position for the mean line amongst the dots. This, however, is a weakness common to nearly all graphs, but in the case of the Parsons line the dots fall so close together that the chance of any substantial error is small. The value of this system of power-plant control lies in the fact that it lends itself easily to a system of bonus payment, which, while eminently fair to the men, is difficult for them to "manipulate."

What the System Involves

In putting this system into operation, a prolonged operating test is required. The necessary charts with coal consumption and water evaporated are then drawn up and the straight lines plotted which represent the average performance of the plant over the period of observation.

Equations obtained from an analysis thereof provide information of considerable importance to the efficient operating of the plant. There is, in the first case, a line representing coal consumed per kw. hour; and in the second, water evaporated per kw. hour. To apply this information to the calculation of a bonus, the actual performance of the plant, when operated by any particular shift, is compared with the standard of fuel or water consumption for the electrical output, and the wages of the men concerned would be increased by the same percentage as the standard has been exceeded.

Advantages of the System

It is claimed by the originator of this method of calculating bonus payments that it provides a useful and appreciated bonus for such savings as are reasonably likely to be made without it becoming absurdly excessive even though the existing standard be very low. This enables the management to guarantee that once established it will not be modified or withdrawn without the operatives' consent, which is an important consideration in inducing them to work co-operatively in improving the operating results. The standards set are not merely theoretical ideals of efficiency, they are based entirely on the average of actual performances, and being manifestly fair, and easy to improve upon, with two definite sets of figures, the men know how their bonus is com-

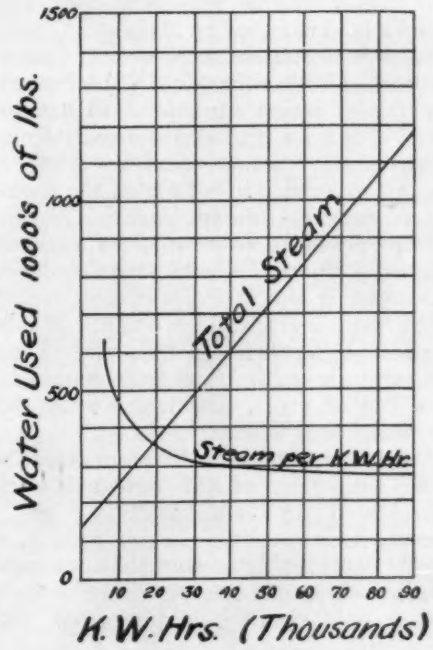


Figure 2

puted. With the bonus based on water consumption per kw. hour, "blowing down" will be checkmated. The evaporation figures may be taken from the readings of integrating steam meters as a check.

A Practical Example

The system first came into prominence by being made use of by Mr. Mitchell, the engineer of the Dalmarnock (Glasgow) power station, one of the largest and most successfully operated stations in Great Britain. The following diagrams show its application to another large power station, Blackburn East. This station has at

(*Continued on page 162*)

Editorials

PATIENCE A VIRTUE

Those of us who work every day in the laboratory with the practical facts of the curriculum tend to underestimate the value of keeping a constant watch for unusual results and supposed facts that do not check.

While it is true that the majority of important inventions and discoveries have resulted from careful and patient research, it is nevertheless true that many other revolutionary discoveries have been the result of accidental discoveries by those whose minds were active enough to grasp the significance of the basic incident.

An illustration of how much "trifles" may mean to one with an active mind is the story of the discovery of the presence of an unknown gas, later named "argon," by the physicist Lord Raleigh.

Raleigh had undertaken to determine the density of the gas nitrogen to a very high degree of accuracy. As it was of course necessary that the samples of gas used be absolutely pure, Raleigh checked samples of nitrogen obtained from the air by the usual methods, which eliminated all known gases, against nitrogen obtained from ammonium nitrate, and detected a slight difference in weight of the gases from the two different sources. As the difference was very small, a man of less discernment would probably have charged it up to experimental error, but fortunately Raleigh was not of this type. Reperforming the experiment several times, he found the same inexplicable error, and found it to be approximately constant.

Co-operating with Professor Ramsey the properties of the new gas were examined and the name, "argon," applied.

It is probably a fact that we pass over every day many "trifles" which may hold the key to important discoveries.

Probably the most lucrative field for discoveries of a revolutionary nature is the investigation of high-frequency phenomena. Light, heat, X-rays, radio waves, are believed to be vibrations in the ether, differing from each other by their characteristic frequencies, or wavelengths. Several spaces occur on the frequency tables, denoting unknown frequencies. We also know nothing of the properties of the very short waves, lying beyond the radioactive radiations.

Someone will build a generator for these radiations. Perhaps the initial thought back of the design will be suggested by some trifling incident which will tell its story to a mind alert enough to grasp its significance.

It is easy to fall into a rut of humdrum existence, but the man who gets ahead is the man who is on his job all the time, and who uses his head as well as his hands.

WHAT IS YOUR OPINION?

The Association of American Engineers recently sent out a questionnaire to various prominent engineers asking for suggestions on the subject of the inadequate fees which many of the profession receive as compensation for their services. The answers vary considerably, but fall generally into two classes. They were published in the *Professional Engineer*, and from this journal we quote two examples which are interesting in the contrasting opinions represented.

Answers to the question: "What can the profession do to combat the evil of inadequate fees?"

1. "The profession can encourage rendering adequate services. The rendering of adequate services would go far toward establishing adequate fees."

2. "The most important thing which the profession can do to combat the evil of inadequate fees is to make a rule against an engineer charging less than a given fee. I have been perfectly amazed during my practice to see the miserable fees for which engineers were willing to have their services engaged. Of course every time an engineer cuts fees, it hurts the profession. I have consistently refused to take work for a sum less than I believed I could perform adequate services for, and if engineers insisted upon having fair compensation, there would be no necessity to combat the evil of inadequate fees. The engineers themselves are to blame for this."

THE ENGINEER AND WORLD PEACE

The world, from time to time, in the years of peace, has seen what can be accomplished by the forces of applied science for the betterment of the human race. The late war demonstrated the result of perverting these forces from their higher uses. There can be few who would suggest in any seriousness that the latter achievements of science were nobler than its accomplishments in peace time, however, for certain branches may have advanced as a result of the conflict.

Among the nations which we call civilized, wars come about from economic and political reasons, jealousy, selfishness, or misunderstanding. It would seem reasonable to suppose that the best way of making war less likely would be by the elimination of as many of these causes as possible. The internationalist would abolish the division of mankind into nations, but man seems to call for some unit of measurable size and more familiar associations to inspire and hold his loyalty. The friendliness, moreover, is not brought about by living in complete seclusion, but by mutual intercourse.

What can the engineer do, then, to promote this international friendliness and respect? Improvements in communication and transportation undoubtedly give greater opportunities for mutual knowledge, and this seems to be one practical and concrete way in which the best interests of industry and humanity can be served at the same time. Familiarity may not remove all causes of distrust or dislike, but it will at least tend to dispose of many of those imaginary ones which are based on ignorance. Travel alone, however, does not go deep enough toward the root of the matter unless it be undertaken without prejudice or is for sufficiently long duration for prejudice to be overcome. The tourist is inclined to adopt an attitude of critical superiority which leaves as untrue an impression as he himself carries away.

Pure science is almost completely international, and the technical societies, by the publication of their proceedings, are tending to put engineering on the same footing. This is excellent, and the extension of this idea seems to offer great possibilities. Invitations to prominent engineers of other nations to speak at meetings might be much more frequently given; international conventions also, held as frequently as possible and in as many different countries as possible. The benefits to be derived from such an interchange of views are sufficiently obvious. There is a thrill and zest in the belief that one is tackling an entirely new situation. In the same way, new light on old methods may reveal unexpected deficiencies. Some small commercial advantage might be lost to some one nation by this interchange, but such advantages are short-lived in these days, and the gain in friendliness would offset it a thousand-fold.

World Peace, unfortunately, is still a dream, but so, at one time, were many other aspirations which have since been realized. If there is anything in the claim that applied science is working for the human good, how could it be better substantiated than by a real effort by engineers to have their part in making this dream a reality?

Recent Books

This department conducted in co-operation with the Technology Library

The Story of Early Chemistry. By John Maxson Stillman, Late Professor Emeritus of Chemistry, Stanford University. New York and London: D. Appleton and Company, 1924. Price, $4.00.

This book is the best account of chemical knowledge and discovery previous to the era of modern chemistry which we have seen in any language. It includes and summarizes the results of researches in this field by modern scholars, among whom Stillman himself is to be included.

Professor Stillman was the first administrative head of the Chemistry Department of Stanford University. Taking the position in January, 1891, he was continuously active until 1917, when he retired as professor emeritus. During this period he gave for fifteen years an advanced course in the history of chemistry, and found time among his other duties for the publication of researches on Basil Valentine, Paracelsus, and Petrus Bonus. His retirement supplied leisure; the university library and the exceptionally fine private library of Herbert Hoover offered unusual facilities; and it is apparent to any reader that he found great pleasure in writing the book. He died on December 23, 1923, before he had seen the proof-sheets.

The book commences with a discussion of the practical chemistry of the Ancients, the preparation of pigments, colored glass, alloys, etc., and continues with an account of the earliest chemical manuscripts, which were scarcely more than books of recipes for the preparation of materials which were used in the decorative arts. There is a discussion of the Greek and Hindu doctrines of the nature of matter. The chemical facts which were known to the alchemists are reported adequately, and the early metallurgical handbooks, *Probierbüchlein*, etc., are discussed more fully than heretofore has been done in the histories of chemistry. Paracelsus is treated without enthusiasm and without prejudice. The great chemists of the seventeenth and early eighteenth centuries, the rise and fall of the phlogiston doctrine, are treated, and the book ends with an account of the Chemical Revolution and of the experimentation which led to our present way of looking at things.

Professor Stillman has adhered strictly to his intention of writing a history of early *chemistry*, for the book contains but very little discussion of the theories of alchemy, and no exposition whatever of the Hermetic philosophy. Emphasis throughout is upon *facts known*, upon *facts used*, but not, until the discussion of the phlogiston doctrine, upon *facts interpreted*. It is these latter, after all, which constitute a science.

The book has the disadvantage that it treats old theories from the point of view of our present theories, a method of treatment which would be proper if our present theories are right — and on this point we can be by no means certain. It seems to the reviewer that it is the duty of the historian to expound a theory in the light of its own epoch, in the light of the idea-system of which it forms a part. For a science is not a collection of facts, however much chemistry may seem to be so to freshmen. It is a collection of ideas. This is the difference between information and knowledge.

The book is lucidly written, and is entertaining to read. It will appeal to any student of the order of things. It can be understood without previous knowledge of present chemistry, and if carefully read will be found to impart considerable of it.

TENNEY L. DAVIS, '13.

Modern Gaging Practice. By Albert A. Dowd and Frank W. Curtis. New York: The Engineering Magazine Company, 1925. Price, $3.00.

The authors of this book have produced other books on mechanical subjects and have contributed also to the leading technical journals.

In their latest work, "Modern Gaging Practice," they have endeavored to treat this important subject in a non-technical way, so that it may be understood clearly by the mechanic and still not be too elementary for the use of the engineer and executive.

In this age of production manufacturing and the interchangeability of mechanical parts, the design, manufacture, and use of gages and instruments for production and inspection play an important part.

The first chapter clearly describes Interchangeable Manufacture and the benefits derived from it, and also gives an interesting outline of its origin, dating back to 1785.

Another chapter discusses the Limit System, with special mention of the dimensioning of drawings and an explanation of tolerances, limits, and allowances which is valuable information for the designer, engineer, and mechanic.

The chapter on Standard and Reference Gages gives an historical review of the development of measurement standards; also the establishment of a gaging system which gives a description of the various gages and precision instruments necessary for such a system.

Chapters IV, V, VI, and VII give a thorough description of the different types of gages, such as work gages and inspection gages, showing their various uses, and their application to different classes of work, also giving the methods of their manufacture, the tools used, and the care of the gages.

The chapter on the Organization and Management of an inspection department is of interest, for it not only treats of the organization and its functions, but also of the inspection of the raw materials, which is important in modern manufacturing, explaining the different kinds of tests necessary and showing the machines used for each.

Chapter X, on Final Testing, treats of the testing of the finished product, whether it be a complete machine, or part, or any piece of mechanism showing the different tests necessary to check up the various operations and prove the accuracy of the completed product.

The last chapter is a discussion of Tolerances, showing the differences in general practice accompanied by several tables on the subject, which are valuable to the manufacturer and a benefit to him in deciding limits.

In addition to the detailed description of the different gages and instruments, and their application, the book is well illustrated, giving the reader a clearer understanding of the subject described. This book will be useful in all branches of mechanical work.

A. B. ENGLISH.

Engine Dynamics and Crankshaft Design. By Glenn D. Angle. Detroit: Airplane Engine Encyclopedia Co., 1925. 299 pp.

Following the great impetus given to airplane engine design by the War, there has been rapid scientific development, resulting in a vast amount of valuable experience and data. The present volume is the first of a series which, according to the publishers' plan, will present this information in the form most useful to designers, covering each branch of the subject in a comprehensive manner. The author was formerly in charge of airplane engine design for the United States Army Air Service.

Non-Metallic Minerals: Occurrence Preparation, Utilization. By R. B. Ladoo. New York: McGraw-Hill Book Co., 1925. 686 pp.

The non-metallic mineral field, as covered by this book, includes primarily those minerals of industrial importance which are mined essentially for use other than as a source of the metals. The author's purpose has been to describe the technology of such minerals, that is, their mining, preparation, and utilization. The work does not pretend to be wholly original nor exhaustive, but rather a compilation of present knowledge from widely scattered sources.

The Interpretation of Topographic and Geologic Maps. By C. L. Dake and J. S. Brown. 1st Edition. New York: McGraw-Hill Book Co., 1925. 355 pp. Illus.

This most useful handbook takes for illustrative material the maps issued by the United States Geological Survey. Introductory pages are devoted to the features of maps, methods of representing topography, etc. The authors' method has been to take up successively various land forms, showing their development and structure, and to refer frequently to specific maps on which the features described are shown in contour, by patterns, or in other ways.

Gasoline: What Everyone Should Know About It. By T. A. Boyd. New York: Frederick A. Stokes Co., 1925. 211 pp. Illus.

This is a popular but reliable account of the production, refining, and uses of gasoline, by an officer of the General Motors Research Corporation, who feels that the average motorist does not know as much as he should about the fuel he consumes. There are useful chapters on the safe handling of gasoline, the obtaining of greater mileage per gallon, and the prospects for a future supply.

Preparation of Scientific and Technical Papers. By S. F. Trelease and E. S. Yule. Baltimore: Williams & Wilkins Co., 1925. 113 pp.

This helpful manual has been compiled mainly for the use of senior and graduate students in the preparing of theses or dissertations, but its directions apply equally to the writing of any scientific or technical report. It does not concern itself with grammar or rhetoric, but with the outlining and shaping of material in the correct form requisite to a presentable, intelligible report. In view of the perennial criticism that a large percentage of engineering graduates cannot write clear, effective reports, this book deserves study by every undergraduate.

Superheat Engineering Data. New York: The Superheater Company, 1924. Price, $1.00.

The intention of the authors in publishing this handbook is to condense for ready reference the data most frequently desired by steam-power plant engineers and operators. Besides containing data and tables pertaining to superheated steam, the handbook has in it many useful tables. There are conversion tables, tables on mechanical standards, calorific tables, etc. A section of the book is devoted to the flow of fluids.

The latter part of the book is devoted to the illustration of numerous typical boilers, together with brief descriptions or comparative figures of a few standard sizes.

This handbook should prove of great value to the student of heat engineering because of its recentness as well as its great wealth of content.

Here and There

Interesting notes from the Editor's desk

ALCHEMY STILL A DREAM

The age-long dream of the alchemists of producing gold artificially is still a dream. This conclusion, announced by the *Scientific American*, was reached after extensive experimentation by Prof. H. H. Sheldon, head of the department of physics of New York University, assisted by Roger S. Estey, an instructor at the same institution, and an experienced physicist and investigator.

Professor Sheldon's experiments were carried out under the auspices of the *Scientific American*.

A process of electrically producing gold from the mercuric atom was announced last year by Prof. Adolph Miethe, of Charlottenburg Technical College, Germany.

Briefly summarized, Professor Miethe's discovery consisted in exposing a small quantity of pure mercury to the action of an intense electric arc inside a quartz tube.

By passing a current of about 20 amperes through this tube, for weeks at a time, Professor Miethe believed the structure of the lead atom to have been changed, forming an extremely small amount of gold.

The *Scientific American's* announcement would make it seem as though a slight amount of gold must have been present in solution in the original experiment in Germany, if Professor Sheldon's results are to be accepted as final.

The most far-reaching effect of such an experiment, should it prove successful, would not lie simply in the transmutation of mercury to gold, but rather in the opposite transmutation of gold to mercury, with the accompanying enormous energy liberated. Thus our fondest dream — atomic energy — would seem within reach.

PARADOX?

In a recent number of the *Sibley Journal of Engineering*, says *Machinery*, Irving P. Church, professor emeritus of applied mechanics and hydraulics at Cornell University, states that a vehicle may be moved directly against the wind by means of a wind wheel actuated by the same wind. When confronted by this statement, a number of scientists and engineers have said positively that such a vehicle is a mechanical paradox and that it will not work. Professor Church states, however, that he has actually constructed a model of such a device and that it does work. Professor Church's wind-locomotive does not tack like a sailboat, but sails squarely into the breeze. The original model of the wind-locomotive is now in the museum of the College of Civil Engineering at Cornell University. The model is about fifteen inches long, supported by three wheels — an undriven wheel in the rear, and two wheels in front driven by round belts from the shaft on which the wings of the wind motor are mounted. It is claimed that this model will make steady progress against the wind, regardless of opinions to the contrary. Professor Church demonstrates mathematically in the article referred to why this is possible, the demonstration being quite elaborate.

Any scheme like this, seemingly paradoxical as it is, causes us to scratch the favorite spot on our cranium. We have never seen Professor Church's model, as unfortunately the railroad company does not recognize even scientific expeditions when issuing free passes. However, we seem to remember an old rule of physics — "Action and reaction are equal." Now if the model is to move forward, it obviously must be a free body, except for the frictional connection of the wheels. It does not tack, but moves squarely into the wind. We can see how the wind wheel might generate enough power to keep the machine in place through the mechanical energy applied to the wheels, providing the wind resistance of the rest of the machine was small enough, but it is past our comprehension how enough excess power could be generated to cause the machine to move forward.

We would be pleased to hear from any of our readers who think they can prove why such a device might or might not work.

HARDENING COPPER

That hardy perennial, hardened copper, has cropped up in the press dispatches again, this time from Lorain, Ohio, where E. E. Harrison, negro foreman, "has perfected a process to make pure copper as hard as tool steel." The news report is defective in omitting the customary reference to rediscovering the lost art of the Mound Builders, or other ancient races, and no prediction is made that surgical instruments, razors, and other edged tools will soon be made of pure, hard copper. Otherwise, the announcement runs true to form, because a "$3,000,000 offer from Eastern capitalists has been refused" by the inventor's attorney, Victor J. Evans, of Washington. A new touch is added, however, in smelting the copper in a vacuum, so that there is even less in this process than in its predecessors.

There is a curious psychology in this business of discovering a method for hardening copper. It breeds in the inventor a supreme indifference to wealth, a haughty and scornful pride that casts aside great fortunes laid at his feet by those mythical, credulous, and greedy Eastern capitalists. In this case the infection seems to have spread from Lorain to Washington — from the inventor to his attorney — for it was the latter who, according to reports, refused the $3,000,000 offer by proxy, particularly when the refusal is all he will get out of it.

As the wind bloweth where it listeth, so hardened copper springs perennially from all points of the compass and all strata of society. The more humble the stratum, the more marvelous the discovery and the more magnificent the gesture of refusing a vast fortune. In all this there is probably no great harm. True, the patent office is burdened with useless junk; but the scientific world is mildly amused, the patent attorney gets his fee, the proud inventor has his brief hour of newspaper fame, and — in this case — also his vacuum.

THIS AGE OF PROGRESS

Heat broadcast from the equator to the poles; light by wireless; "free" power; business deals closed in "telephatic conversations"; flying automobiles; these are some of the things in store for mankind in the years to come, according to Professor A. M. Low, London scientist.

Low, who recently wrote a remarkable phantastic-scientific work, "The Future," says that the things pictured in his work are neither "romance nor talking through the hat."

All these unusual things in the future have been carefully and scientifically charted out by Professor Low.

"Take electric light. Think of the waste of power. Less than one half of one per cent of the power is converted into light. Engineers will never stand for that. Improvement is bound to come. Wireless waves and light waves are the same, it is only a question of the length of the wave. Some day scientists will shorten the wireless waves—and we will have wireless light.

"Power will be broadcast from great central stations and will be free like water.

"The demand for speed and yet more speed will shorten business conversations to a matter of seconds or fraction of seconds. A few rapid facial expressions and some thought waves will serve the purpose of the present-day thirty-minute conversation.

"Already they are doing practically the same thing on the floors of our stock exchanges."—*Associated Press.*

Professional Notes

Activities of the Undergraduate Engineering Societies at the Massachusetts Institute of Technology

COMBINED PROFESSIONAL SOCIETIES

The purpose of the organization known as the Combined Professional Societies is to promote co-operation and prevent duplication among the several separate societies and to stimulate interest in general engineering subjects at the Institute.

The principal activity in the latter respect for this year will be the presentation of a series of movies of general interest to engineering students. It is planned that six or eight such pictures will be presented during the course of the year bearing on the subjects of manufacturing, construction, mining, aeronautics, etc. The pictures will be presented at the time which will be convenient for the greatest number of students to attend, and they will be open to all who are interested.

Another activity of the Combined Professional Societies is the annual "Open House Night," which is held early in the spring. On this occasion students of other institutions and the general public are given an opportunity to make a complete tour of the Institute buildings and see Technology in operation.

AERONAUTICAL ENGINEERING SOCIETY

As guests of the Aeronautical Engineering Society, the whole student body was invited to attend the first talk of the year, when Commander John Rodgers, U. S. N., spoke in Room 10-250 on the afternoon of November 2, at 4 o'clock. After successfully flying his plane 1600 miles of the distance from San Francisco to Hawaii, Commander Rodgers was forced down 450 miles short of his objective, owing to lack of fuel, and then successfully sailed his plane the rest of the distance to the island of Kauai.

The second function of the year was a smoker, held on the evening of November 4, when Lieut. Carl Shumway, U. S. N. R., told of his experiences as pilot of the *Shenandoah* and *Los Angeles*. His talk was well illustrated by the showing of two reels of films taken of these airships in flight. Two other reels were also shown depicting the heavier-than-air activities of the Navy. This first smoker was in the nature of an informal business meeting to start the activities of the year.

The Society is at present busily engaged in producing a small wind-tunnel model to be exhibited in the Aviation Show to be held in the Mechanics Building from December 2 to 5 in connection with the Army-Navy Bazaar to be held at that time. An electrically driven propeller will furnish the wind, which will flow over a small model, suspended in the conventional way, with the object of determining the lift and drag forces on the model, which are then scaled up to give full-size effects. (M. I. T. is the possessor of a 4½-foot tunnel which has contributed much valuable knowledge to the Aeronautical Industry in the past, and a newer 7-foot tunnel which is one of the largest in the country and is giving more accurate results than was formerly thought possible.)

CIVIL ENGINEERING SOCIETY

The Civil Engineering Society opened its year with a smoker-meeting on Friday evening, October 23. At the meeting several amendments to the Constitution were passed, among them being one which provided a new class of membership open to freshmen, to be known as Junior Membership. Junior members were not to be allowed the voting privilege. Professor Hosmer and Dr. Terzaghi were elected honorary members.

Professor Spofford spoke briefly on the value of participation by engineers in the proceedings of a professional society.

Col. Charles R. Gow, the chief speaker of the evening, gave a talk, illustrated by lantern slides, on "Foundation Experiences."

On Thursday, November 5, the Society conducted a trip to the Dorchester extension of the Andrew Square tunnel. City engineers pointed out the features of interest in this work.

ELECTRICAL ENGINEERING SOCIETY

The first meeting of the Society was held on Friday, October 16, at which Prof. H. B. Dwight spoke on "The Power Possibilities of the Niagara and St. Lawrence Rivers." Dr. Dwight's talk has been written up and is published in this issue of THE TECH ENGINEERING NEWS.

The second meeting for the year took place on Friday, November 13. Mr. Everett S. Lee spoke on "What Every Engineer Must Sometime Do." Mr. Lee said that every engineer must at some time measure something, and he told of some of the interesting things which have come up in connection with the testing of large machines, cables, and other electrical apparatus in the shops of the General Electric Company, with which he is connected. Mr. Lee is a nationally known authority on this subject, and has gained much prominence in connection with a number of papers which he has presented to the American Institute of Electrical Engineers.

On Wednesday, October 28, about thirty members of the Society made a visit to the L-Street Station of the Boston Edison Company. Other trips are being planned, and it is expected that before the end of the year a great many places will be visited which will be of interest to electrical students.

CHEMICAL SOCIETY

The first smoker of the year was held on Wednesday evening, October 28. Dr. J. F. Norris, professor of organic chemistry at the Massachusetts Institute of Technology, head of the National Research Council, and president of the American Chemical Society, spoke on "Chemistry and World Problems." In his talk Dr. Norris cited many problems which chemistry was solving for the good of humanity. The problem of food supply, he showed, was solved by chemistry, since the use of fertilizers made possible very intensive farming, which in turn made possible a greater concentration of human beings per square foot of the earth's surface. He also showed how chemistry, by decreasing the cost of products to the consumer, increased the happiness of the human race. The case cited here was the use of lacquer instead of paint for finishing automobile bodies. He pointed out that, through chemistry, much labor was saved, thereby giving man more time for developing the less material things. All this progress, he said, was made possible only through diligent and conscientious research.

A trip was made to the Lever Brothers Soap Works in Cambridge on Thursday afternoon, November 5. A goodly number of members made the trip, and a very comprehensive insight into the manufacture of soaps was obtained. The men were shown from the boiling of the soap in vats through to the packing-room, where the soap is packed and sent to market.

The officers of the Chemical Society are planning for a very active year. Another smoker will be held late in November, while several trips to chemical plants in and around Boston will be made in the meantime.

The Engineering Field

Excerpts from the leading professional and trade journals

A Sleeve-Valve Airplane Engine, made by the Parhard Levassor Company, has just recently passed the 240 hr. test in the French Government endurance contest. It succeeded in doing this on its first trial, and is now waiting for some of the other types of motors which failed in their first attempt to make their second trial. The engine is of the Knight sleeve-valve type, embodying also many features on which the company manufacturing it holds patents. Its height is exceptionally small as compared with that of the conventional poppet-valve engine, amounting to only 35.4 inches, while that of most of the poppet-valve, overhead-cam engines is from 47 to 49 inches. In order to reduce the weight of the sleeves, they have been built of steel instead of cast iron, while special construction of the piston rings has decreased their weight materially. The motor is a twelve cylinder V type, delivering 450 h. p. at 1500 r. p. m. and 550 h. p. at 1800 r. p. m., and has a net weight of 1157 pounds.

Balloon Tire Losses. The result of investigation made by the Bureau of Standards of the efficiency of the balloon tire shows that the rolling resistance of the balloon tire is more than the high-pressure cord and less than the high-pressure fabric.

On smooth roads there is a difference in gas consumption in favor of the cord tire. However, on rough roads there is no appreciable difference, as the balloon tire decreases the vertical bounce of the automobile.

On the basis of inflation pressure of 30 pounds for balloon and 50 pounds for 4-inch high pressure, the average rolling resistance for the cord tire is 11.8 pounds per 1000 pounds axle load, while for balloon tires the rolling resistance is 13.5 pounds, and for fabric tires the resistance is 17.1 pounds.

Uninflammable Celluloid. There has been for many years a not very successful searching for an uninflammable celluloid. The manufacture of an uninflammable fiber has been accomplished, but is of too high a price to be considered as apt for mass production. Recently, however, the German chemist Carl Schmidt succeeded in composing a substance having the same qualities as celluloid and standing temperatures of 60° to 75°C. The material in question is a filling substance whose origin is a waste product in the industry and whose price of manufacture is comparatively low.—*Translated from the German.*

High Frequency Work. Taking immediate advantage of the recent demonstration of the efficacy of short wavelengths by amateur experimenters, commercial interests have begun a series of tests with a view of determining their usefulness for trans-oceanic radio traffic.

The Marconi Company has obtained singular success in this work by the use of reflectors at the transmitting end to concentrate the emission. Their station at Poldhu, with an input of only 12 kw. to the antenna, is able to work direct with Sydney, Australia, almost diagrammatically across the earth, on about 32 meters wavelength.

This field of work becomes extremely alluring when one realizes that the average long-distance commercial station today uses power of from 200 to 400 kw., together with a very expensive antenna and ground arrangement.

In the great majority of cases, short waves have not proved entirely successful as yet, however. This is because the very nature of commercial radio traffic requires that it be sent out immediately upon being filed. The amount of power received on waves of 100 meters down varies greatly with the time of the day, the signal often dropping completely out of audibility for a time. This naturally is a great drawback for commercial work.

It is to be hoped that a way will be found to obviate this difficulty in the future.

There is an entirely unexplored field in the extremely high frequencies of from five meters down. What work has been done here has been of a sporadic nature, and therefore little is known of the capabilities for long-distance transmissions of such high frequencies. There is hope here for development along the lines of high angle transmission, or a beam of waves directed upward to be refracted toward earth again at a distance. Some such scheme as this will probably have to be used because of the high absorption of the short waves if forced to travel along the earth's surface.

A Turbine of novel form has been built and tested in the Danube River near Vienna. The structure is a large tube which contains a form of propeller delivering power to a small generator. The tube is on floats, and the whole structure anchored in a swift current so that the flow of water actuates the propeller.—*Science and Invention.*

Transmission of Colored Pictures by Radio Now Theoretically Possible. Mr. C. Francis Jenkins, inventor of the most practical system of transmission of motion pictures by wireless known at the present time, announced recently a method whereby the picture may be transmitted in its natural colors.

Mr. Jenkins' method is based on much the same scheme as is used by all magazine printers for lithographing the colored cover.

To quote Mr. Jenkins: "It is well known that pictures in color are in common use in magazine printing, in window transparencies and decorations. The process consists of making three negatives, one through a red screen, a second through a green screen, and the third through a blue screen. When transparencies from the three negatives, each stained with its complementary color, red, green, and blue, are superimposed and viewed by transmitted light, the resultant picture is seen in its natural color.

"With this process well known, it is obvious that three such negatives transmitted by radio could be colored and combined to make a radio picture. Of course, the picture is not sent in color, and I hesitate to claim for such a feat more than that the resultant picture proves the excellence of the synchronism of the machines employed in the transmission of the three successive pictures, which, after they are received, are to be colored and combined into one."

It is interesting to note that Mr. Jenkins has recently offered, through "QST," the official organ of the American Radio Relay League, cash prizes for suggestions for improvements on his picture machines. One aspirant succeeded in winning a $50 prize by suggesting that the usual pen-and-ink method of reproducing the picture at the receiving end, which is used on Jenkins' simpler models, be superseded by a carbon paper laid over the usual sheet of white paper, and the messy pen and ink be replaced by a metal stylus.

Magnus Effect Propeller. Experiments are being made to apply the Magnus effect to airplane propellers. The driving-power of the well-known Flettner rotor-ship is obtained by utilizing this effect. Present models consist of a propeller-like device having rotating drums in place of the two customary vanes, the whole revolving as a propeller.

While theoretically correct, this type has yet to prove efficient.

Chromium-Faced Plates. Until a few years ago, all plates at the Bureau of Engraving and Printing were made of steel and then case-hardened. In order to meet increasing demands, an electrolytic process for reproducing the plates was introduced. But the nickel-faced electrolytic plates do not resist wear as well as the case-hardened steel. And in order to increase the useful life, the application of extremely hard chromium metal was undertaken successfully.

It is possible to produce a printing plate with a chromium surface by either of two methods: (1) By depositing an initial layer of chromium instead of nickel upon the form or negative plate, or (2) by depositing a thin layer of chromium upon the nickel surface of the finished plate. Because of difficulties involved in the first process, the second method was adopted. Experience has shown that the thickness of the chromium plating need not exceed .0002 of an inch in order to yield a greatly increased service. As there are no significant lines in the engraving that are less than .002 inch wide, i. e., ten times the thickness of the coating, no appreciable change in the design or the impressions is produced by the plating.

The results indicate that "back" plates will last several times as long as the nickel-faced electrolytic plates and at least twice as long as case-hardened steel plates. On "face" plates chromium has been found particularly valuable because the life of both steel and electrolytic plates has hitherto been very short. The chromium is applied to steel plates which have not been case-hardened, and thus a troublesome and expensive operation is eliminated. Another great advantage of the chromium surface is that it can be renewed. The worn plating can be stripped off and a new surface deposited without any loss of definition.

The impressions from the chromium-surfaced plates are identical almost up to the point of failure, whereas with the steel or nickel-faced plates there is a gradual but constant loss of definition.

Artificial Larynx. Hitherto, when it became necessary to remove a cancer victim's larynx from the throat in a surgical operation, the patient has of course lost the power of speech. In an attempt to benefit these unfortunates, Dr. Harvey Fletcher and Messrs. Wegel and Lane have recently developed an artificial larynx made of rubber, after suggestions made by Dr. John E. Mackenty, of New York City.

The device consists of a hard rubber mouthpiece and an attached cylinder containing a vibrating membrane of pure rubber. It is connected by a flexible tube to the throat of the user at the point where his windpipe, owing to the surgical operation, communicates directly with the open air.

The necessary vibrations are produced by the rubber membrane and are modulated by the mouth, tongue, and teeth in the same way that the vibrations produced by the larynx of a normal person are modulated into intelligible speech. There is an opening in the side of the artificial larynx, so that the wearer may breathe. When the wearer is talking, the opening can be temporarily closed with the thumb.

The speech produced differs from natural speech in that it is heard in the form of a low-pitched monotone, but it is perfectly intelligible. The speech is clear enough so that the user may converse over the telephone if he wishes.—*The India Rubber World.*

Spontaneous Combustion of Cotton is, in general, held to be due to an oxidation of the cotton oils and the consequent heat, evolved by the chemical reactions, which gradually raises the temperature of the cotton to the ignition point. However, an entirely new theory has been developed by Andre Dubose, who says that the evolution of heat is brought about by the action of the enzyme, lipase.

Lipase owes its existence to the action of bacteria living in the slimy and nitrogen-containing parts of the cotton plant, and has the power of splitting fatty substances, an exothermic reaction resulting in the evolution of a large amount of heat. While the bacteria develop best at a temperature of 25° to 30° Cent., and are killed at higher temperatures, the action of lipase is greatest at a temperature of 35° to 50° Cent., and, when the temperature is raised to 100° Cent., its activity is negated.

The heat developed is not dissipated, but is stored in the interior of the mass of cotton until the temperature rises to the ignition point.—*Am. Dyestuffs Reporter.*

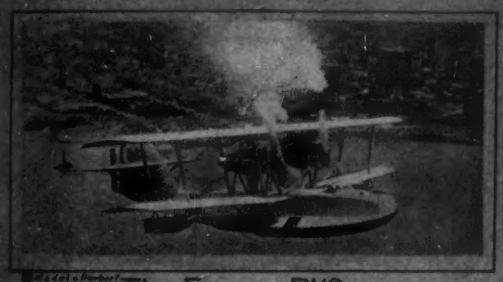
Flameproofing with Selenium. According to recent discovery, the element selenium, although itself completely combustible, has the property of flameproofing insulation on electric wires; and one wire treated with it will render several untreated wires, wound into a bundle with it, flameproof. In some remarkable way, the action is connected with the smothering of the flames by the inflammable selenium vapor, as the insulation ceases to burn only after the igniting flame is removed.—*American Chemical Society.*

Transmutation of Mercury to gold seems partially discredited by the *Scientific American's* experiments. The conditions described by Dr. Miethe were duplicated as exactly as possible, except that mercury from a gold-free source was used. Then an improved lamp was designed by the experimenters to give better conditions for the hoped-for change to take place. In both instances absolute failure to find traces of gold indicated at least that Dr. Miethe's experiment does not always result in the formation of gold. Whether or not the mercury used by Dr. Miethe contained gold before the experiment is still an open question.

An Analytical Balance in which the pointer is replaced by a beam of light, possessing many advantages in accuracy and speed of weighing, has recently been perfected by Wm. Ainsworth & Sons. The device reads the deflection of the balance beam by means of a ray of light projected from a six-volt electric lamp to a mirror on the beam, thence to a mirror in front of the index, which reflects it to a third mirror in the top of the balance cabinet, and finally to an index scale in front of the balance mechanism and in the line of vision of the operator. In analytical balances of the usual construction, this affords an optical lever five feet long, or seven times the length of the usual pointer attached to the beam, making it possible to weigh with greater precision, or more rapidly with equal precision by alterations in the center of gravity of the beam to increase or decrease its period of vibration. The elimination of parallax and of eye-strain is equally important.—*Industrial and Engineering Chemistry.*

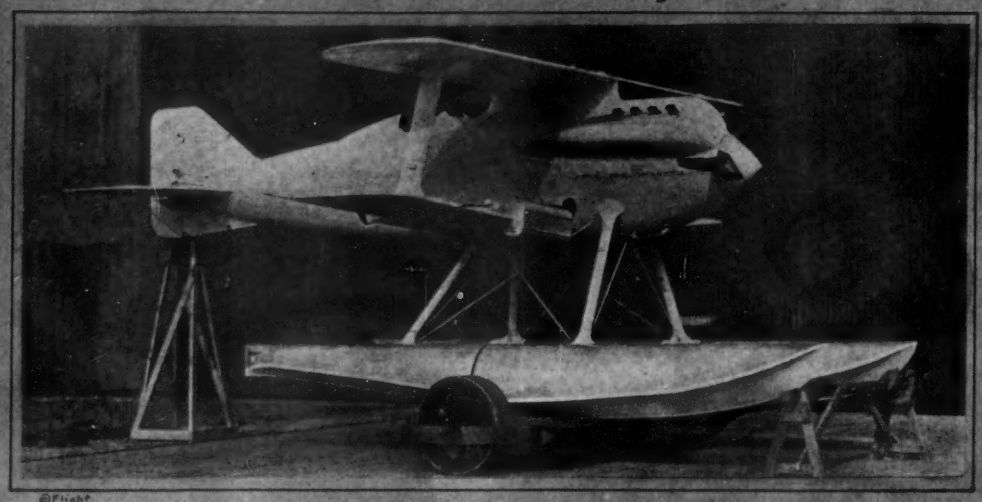
Salvaging Liner of Built-up Gun. When the process of making built-up guns was still in the experimental stage, water-cooling was once tried on the outer hoop to hasten completion of the operation. When the entire gun was cool, the outer two bands were found to be loose. The cooling of the outer cylinders contracted them against the hot expanded inner members so that they became overstressed, which caused permanent enlargement.

Recently, when a large forging was wanted, knowledge of this misfortune was turned to good account. One of the "in-between" cylinders of an old gun was salvaged by loosening and removing the outer cylinders by this pre-cooling method with water, then the inner liner was removed by the usual refrigeration method. The cost of the forging thus obtained was far below that of a new one.—*Army Ordnance.*



The Famous PN9.

Army Pursuit Plane.



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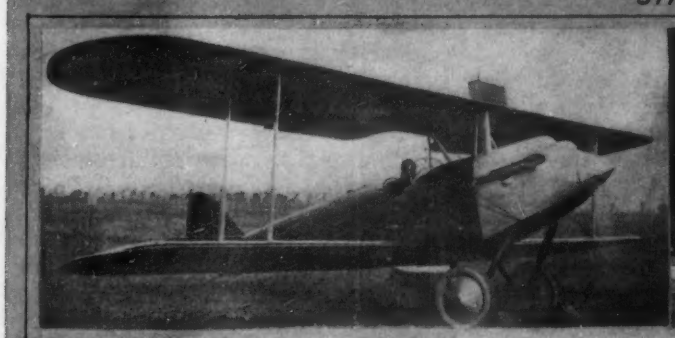
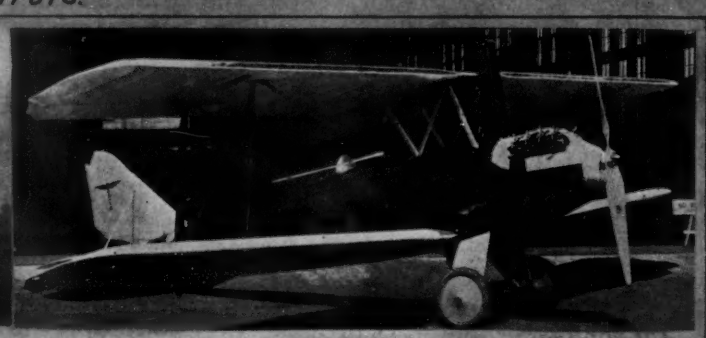
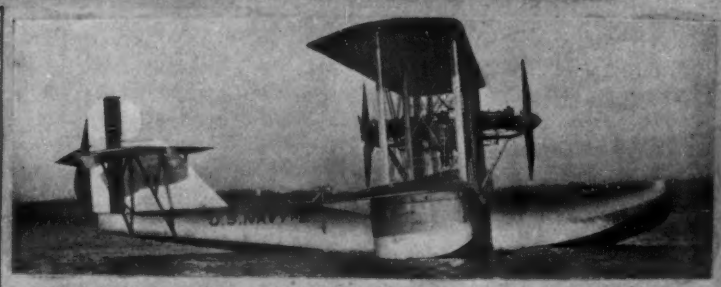
The Gloster Napier III
British Schneider Cup entry using duralumin floats and steel struts.





A Laird Commercial.



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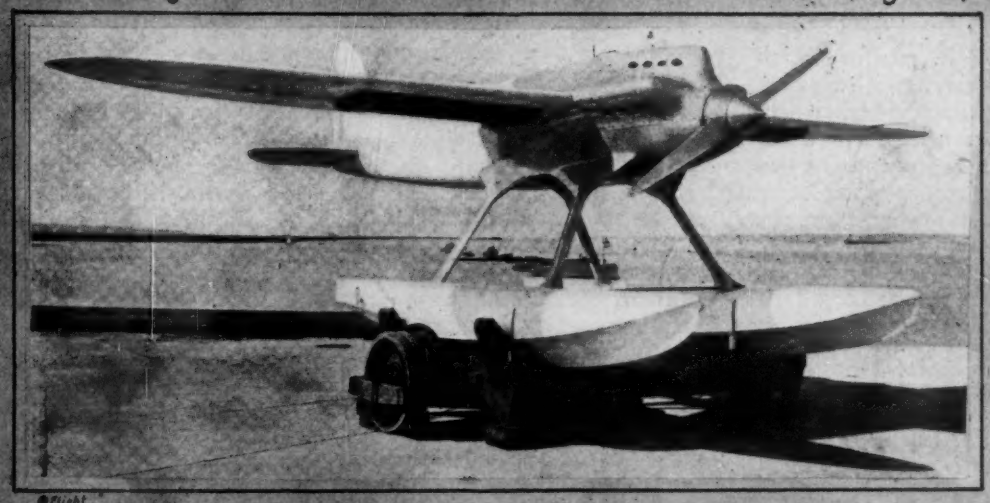
Curtiss Ireland Comet.
The race for supremacy in the "tourster" class has produced four splendid planes.

(Above) The PB1 has engines like those in the PN9, but placed in tandem (Right) The Fokker F7A a passenger type having three 200H.P. radial, air-cooled engines to give great reliability.

© Int. Newsreel

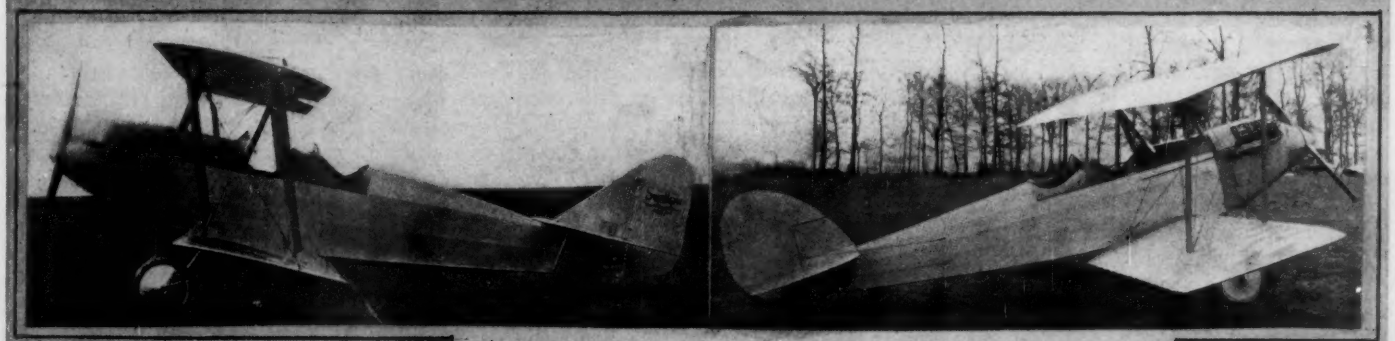
The Wright Bellanca.

The Loening Amphibian.



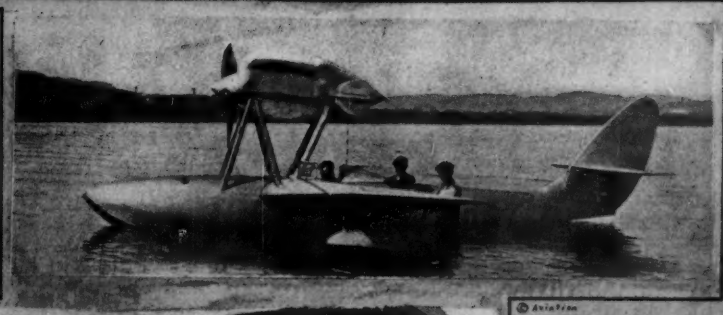
The Supermarine Napier S4

British Schneider Cup entry with wing flap gears to reduce landing speed.



The Swallow.

The "toursters" carry three passengers, with the power furnished by a 90H.P. Curtiss OX5 motor.



The Waco.

(Above) The Macchi Racer, the Italian Schneider Cup entry.

(Left) A Curtiss Carrier Pigeon, designed for air mail service. All control surfaces are interchangeable.

Water Power Possibilities of the St. Lawrence and Niagara Rivers

(*Continued from page 145*)

Lake Erie and the lower Detroit River could be kept higher in low-water seasons, such as the present one.

An additional dam might be built a few miles above the Falls to provide storage a few hours at a time, and so allow a larger peak load to be carried by the power-plants.

The total of the above developments comes to 6,000,000 h. p., for which there is sufficient water, and for which the unit cost is probably sufficiently low. The question arises, could an immediate market be found for so much additional power, or would it be necessary to wait for years for the market to be gradually built up? It is probable that the only way in which an immediate market could be found would be to build transmission lines to large cities, as indicated in Figure 1.

Over three and one-half million horsepower of the additional power would be Canadian, and although there is an incipient power shortage in Ontario at present, a few hundred thousand horsepower would fill present demands and normal growth. The question of bringing industries from the United States in large numbers to use this power is one on which opinion in Canada is divided.

There is, without doubt, a strongly supported opinion in Canada, though it is not unanimous, that the export of power should be completely prohibited so as to force industries to locate in Canada.

This question is more an economic and political question than an engineering one. However, engineers should form their opinions on such questions, though statements cannot be given by anyone with the same confidence that one would give a mathematical result. A debate on this subject was held by the Engineering Institute of Canada in Montreal last winter, and opinion was about equally divided. The one side said that to export any electrical power was like having a transfusion of blood to build up the commercial health of your competitor. The other side emphasized that they were just as loyal to Canada as anyone, but only a few industries, like the pulp and paper or aluminum industries, could move to Canada. Others would be prevented by the American tariff, or electric power would be only an incidental to them. Therefore the choice was not whether it was desired to bring industries to Canada or not, but the choice lay between allowing the water to run to waste year after year, or developing it at once and selling the surplus, as would be done with any other kind of surplus product.

Looking at the matter in this way, the statement can be made that if an equitable price is paid, and if the required future Canadian use of the power be safeguarded by suitable agreements, it is in the interest of Canada as well as of the United States that the power of the St. Lawrence and Niagara Rivers be developed and transmitted to large cities wherever it is economical to do so.

It was agreed by many on both sides that too many water-fall rights had been given away for almost nothing in the past, and a proper price should be paid for them, either as first cost or as rental. It does Canada very little good if an outside corporation acquires a water-power site for a nominal sum, develops it, and takes both the power and the income out of the country. The export duty on power, recently imposed, tends to correct this situation, as well as tending to induce industries to come to Canada for cheaper power.

It may be mentioned that while the frequency of twenty-five cycles is standard in the Niagara district, it would seem to be the best engineering to use sixty cycles for large future developments, so that energy can be transmitted to other districts with complete freedom.

If 300-mile lines are built to carry very heavy power loads, they would require the use of synchronous condensers in intermediate substations, as has been proposed in recent years but not yet used in actual practice.

Synchronous condensers have been used for some years at the load end of long transmission lines, and it has been known that there is a limit to the amount of the power load of such a system. This limit is approximately inversely proportional to the reactance of the line. Thus the limit of load of a 300-mile line might be 140,000 kw., and it might be profitable to put a larger load on the line. This could be done by putting a large synchronous condenser at the middle of the line, controlled to maintain constant voltage. The limit of load will now be calculated almost as if for a 150-mile line, each half being treated more or less separately, and so a larger load than 140,000 kw. could be carried.

To look at the matter in a little more detail, it can be shown mathematically that when the load increases so as to approach the limit, an increase in field current of the synchronous condensers, which normally raises the voltage, no longer does so, but produces a drop in voltage instead. When this happens, the voltage drops to a low value, the synchronous condensers drop out of step, and the transmission line ceases to function.

Usually a trouble of this kind is discovered by hard experience, but this trouble was prophesied three or four years ago by some engineers, and the cure was stated to be intermediate synchronous condensers. The phenomenon was not actually observed on a transmission line till last year. The 240-mile line from Big Creek to California is calculated to have a load limit of 180,000 kw. This load was actually reached, and at 183,000 kw. the synchronous condensers dropped out of step. The voltage dropped nearly to zero and then built up slowly to normal. In about fifteen minutes the load again reached 183,000 kw. and the phenomenon was repeated. This was stated to be the first time that a long high-voltage line has passed through this unstable condition. (See papers by H. A. Barre, *Electrical Journal*, June, 1925, and by C. L. Fortescue, *Journal A. I. E. E.*, September, 1925.)

Calculations of this phenomenon are not very short, and the above short description may be of interest to those who have not followed the matter closely. It is evident that if the load is large enough so that the condensers are almost ready to drop out of step, a surge in current or voltage can make them do so. Valuable results on this question of stability under transient conditions have been published by Prof. V. Bush, of the Massachusetts Institute of Technology, and R. D. Booth.

In conclusion, reference may be made to a new type of tubular transmission line conductor, which seems suitable for long, heavy-powered lines such as those referred to. This is made by laying wires on a twisted copper strap.

The voltages of 150 and 220 kilovolts have given such good service that if a 300-mile line of maximum power is built in the next few years, a slightly higher voltage, such as 250 kilovolts, might easily be chosen. The corona loss at such a voltage would make a conductor diameter of over one inch desirable, and this could be conveniently obtained by using a tubular conductor. Further, the stability limit of load depends on the reactance, and the tubular conductor, because of its larger diameter, would have less reactance, and a greater limit for the power load.

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The Parsons Line

(*Continued from page 151*)

the moment two 10,000 kw. turbo alternators taking steam at 200 pounds and 588° F. from seven B & W marine-type boilers, each with an evaporative capacity of 50,000 pounds per hour at 210 pounds pressure and 600° temperature. The trial upon the results of which these charts have been plotted continued for four weeks and comprised 84 consecutive shifts, during which time the total output was 1,821,-620 kw., varying from a minimum of 3000 kw. per shift to 50,000 kw. per shift of eight hours.

The coal consumption diagram is shown in Figure 1, from which the following equations were deduced:

$$C = 18600 \text{ plus } 1.540\ K \quad . . (3)$$

C and K being as before, while R, the average coal consumption in pounds per kw. hour generated, is given by the expression:

$$R = 18600/K \text{ plus } 1.540 \quad . . (4)$$

From the diagrams so obtained a standard coal consumption corresponding to any electrical output can be determined. For instance, at the lowest output per shift of 3000 kw. hours, the coal consumption is found

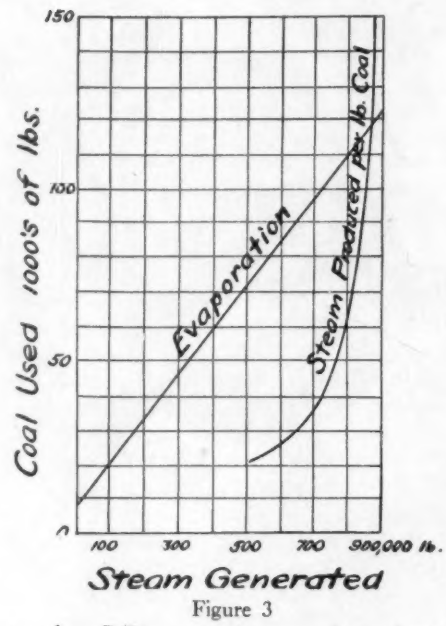

Figure 3

to be 7.74 pounds per kw. hour, whereas at the highest output this is but 1.91 pounds.

The figure for no-load coal consumption is 18,600 pounds per shift, this being necessary to run one unit light and to cover all banking, radiation, leakage, and auxiliary losses for one shift. After this constant no-load consumption has been met, there is a net rate of coal consumption for each electrical unit generated, this represented by the slope of the line = 1.540 pounds per kw. hour. This may be regarded as the coal consumption rating for the station apart from no-load losses.

Figure 2 gives the results in terms of steam per shift, and in the same way as before two formulas are evolved for

W — the total water evaporated in pounds per shift,
and
U — the overall steam consumption in pounds per unit generated,

while the slope of the line gives the steam consumption rating. These equations may be combined to give E the evaporation in pounds of steam per pound of coal.

$$W = 100{,}000 \text{ plus } 11.776K \quad . . . (5)$$
$$U = 100{,}000/K \text{ plus } 11.776 \quad . . (6)$$
$$C = 5522 \text{ plus } 0.1308W \quad . . . . . (7)$$
$$W = 7.647C - 42217 \quad . . . . . (8)$$
$$E = 7.647 - 42217/C \quad . . . . . (9)$$

(*Continued on page 164*)

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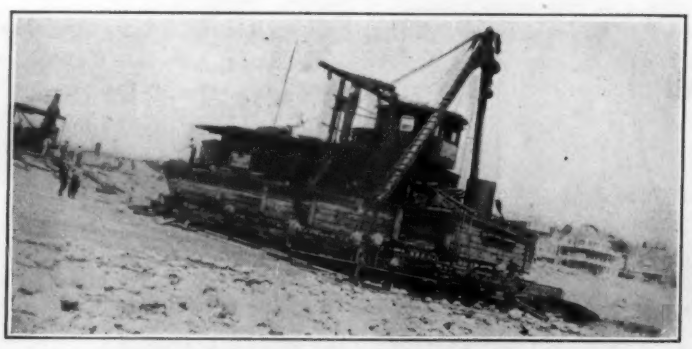

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The Parsons Line

(*Continued from page 162*)

The evaporation line can also be obtained by directly plotting the water evaporated against the coal consumed, as shown in Figure 3. Therefrom it will be seen that when no steam is being generated a coal consumption of 5522 pounds per 8-hour shift is required in order that the boilers shall be at full pressure to cope with load at any moment. This quantity of coal, therefore, represents the no-load losses in the boiler house. The total no-load consumption has already been given as 18,600 pounds of coal per shift, so that $18{,}600 - 5522 = 13{,}078$ pounds of coal per shift is consumed in making up no-load losses in the turbine room.

From equation 9 it will be seen that the evaporation tends to a limiting value of 7.647 pounds per pound of coal.

The Parsons line for a station established by this method of analysis forms criteria from which the operating results on any and every subsequent shift can be compared, whatever the output. It gives a standard water and coal consumption for a station at all loads, and represents the average actual performance during a period when that station was run with scrupulous attention to detail. In other words, it provides an ideal to be worked to—not a theoretical ideal, but one known to be obtainable under practical working-conditions. Notwithstanding this fact, several prominent engineers have criticized the system principally in regard to the line being straight. It should be remembered, however, that the Parsons line is not an exact law of nature, but is purely an arbitrary standard, a developed application, in fact, of the Willans law. Drawn through a number of readings, this line may well be a straight line for practical purposes, although strictly it is not so. As a straight line simple equations may be written to it, and with two or three known results others may be closely approximated. The line being a standard for the particular plant in question, the shift engineers can be encouraged to keep subsequent readings below it, and it would be upon the keeping of these readings below the line that bonus payments would depend.

It is essentially a good system for fixing the basis of equitable bonus payments, and although, perhaps, imperfect, it is probably the least imperfect of any yet devised.

A Survey of Physics

(*Continued from page 143*)

method of mechanics, and it needs to be pointed out that the most advanced students of mathematical physics are but little better off than the reader in this respect, for no one as yet has any intuitive appreciation of the principle of least action nor any conceptual insight into its meaning. The mathematical physicist only knows how to formulate the principle mathematically and how to derive its consequences. The principle of least action applies to all mechanical phenomena, to all electromagnetic phenomena (including light), and to all thermal and chemical phenomena; but it fails in all these fields when there is any irreversible action. Because of this failure of the principle it is better to say that the principle of least action is useful in correlating mechanical, electromagnetic, thermal, and chemical effects when the accompanying irreversible action is negligible. All of these effects are highly idealized when irreversible action is ignored, because every phenomenon in nature is accompanied by some irreversible action, and, of course, irreversible action is very much in evidence in many thermal and chemical phenomena.

(*Continued on page 166*)

The Tech Engineering News

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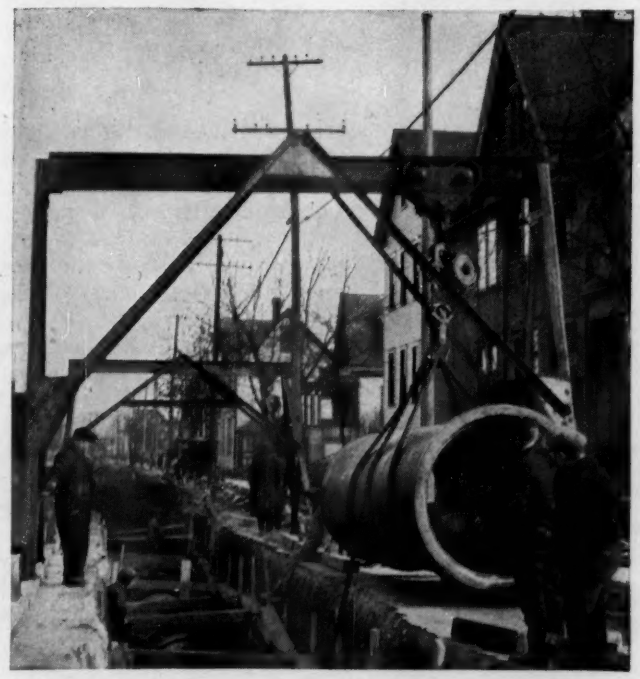


Where dependability is vital

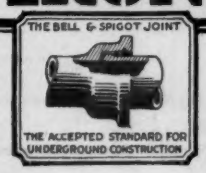
IN connection with a new pumping station at Milwaukee, Wisconsin, additional feeder mains were required. It was necessary that one of these should carry an unusually large proportion of the water supply, and 54-inch pipe was decided upon. Although pipe of material other than cast iron had a lower first cost, Cast Iron Pipe was chosen because the possibility of interruption to service had to be reduced to a minimum.

The photograph above shows a section of pipe being lowered into the ditch in the process of laying it.

THE CAST IRON PIPE PUBLICITY BUREAU
Peoples Gas Bldg., Chicago

CAST IRON PIPE

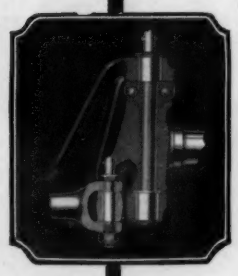
Our new booklet, "Planning a Waterworks System," which covers the problem of water for the small town, will be sent on request



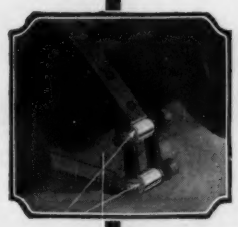
Send for booklet, "Cast Iron Pipe for Industrial Service," showing interesting installations to meet special problems

Good Automobiles Are Known by Their Bushings

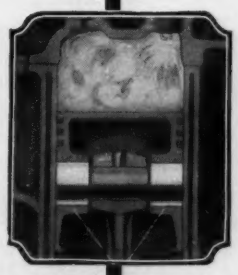
THE motor car is a conspicuous example of how a small and inexpensive part can vitally affect a costly and complicated mechanism. It is not economy to bush a car with inferior bronze alloys, brass tubing, iron or steel bushings just because it can be done for a few cents less per car.



Wabbly, difficult steering and uncertain control of the vehicle is the price paid by the motorist for poor quality bushings put into steering knuckle and tie rod by the manufacturer.



The spring eye and shackle bolt bushings are subjected to the most gruelling punishment. Anything less than a fine phosphor bronze bushing of sufficient size soon wears out.



The piston pin bushings must withstand incessant and terrific shocks in the hottest part of the engine—no place for taking chances on quality.

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A Survey of Physics

(*Continued from page 164*)

Another method in physics, the method of thermodynamics, overlaps the method of mechanics but goes beyond the method of mechanics inasmuch as it recognizes the existence of irreversible or sweeping processes in nature; but the method of thermodynamics has nothing to do with irreversible or sweeping processes themselves, but only with their results, and indeed with only one result, namely, the increase of entropy.

Another method in physics is the atomic method, or atomics, as it is often called. It is certainly true that atoms themselves are now the objects of observation and measurement in the laboratory, but only when the fourth method, the statistical method, as described below, is used. The great theoretical structure which is called the atomic theory, especially that branch of it which is called statistical mechanics (Gibbs), of which the kinetic theory of gases is a special case, is based even now on postulates; for no one could maintain that our real knowledge of atoms is of the kind that could be used as a foundation for any elaborate mathematical structure. The atomic method is the building up of elaborate pictures or conceptions of physical conditions and things, and its chief function is to make physical conditions and things intelligible or thinkable. The kinetic theory of gases, as it exists in the mind of a physicist, is pretty nearly a working model of a gas, and it enables the physicist to "see" the properties of a gas as effectively or even more effectively than he could see them in an actual working model.

A fourth method in physics is the statistical method. The best examples of the use of this method in the laboratory are, perhaps, Perrin's experimental studies of the Brownian motion and Rutherford's experimental studies of the scattering of alpha and beta rays. The statistical method as used in the kinetic theory of gases and in statistical mechanics is a purely theoretical structure, and it belongs to the atomic theory, whereas by "the" statistical method we mean the laboratory study of actual erratic things and the interpretation of the observed results by the use of the theory of probability.

The characterization of physics in terms of methods seems to be more significant than the older subdivision of physics into branches according to subject-matter. Thus mechanics, hydrostatics, hydraulics, heat, optics, acoustics, electricity, and magnetism are the old branches of physics, and the boundaries between these branches are rapidly disappearing with the advancement of physics; in fact, chemistry can no longer be thought of as a distinct branch of physical science. The branches of physical science grow less and less distinct as physical science develops, but the methods as above enumerated and briefly described are being more and more clearly recognized as distinct methods; and, what is even more important, every one of these methods has been more and more strengthened by modern discoveries. Thus Maxwell's theory has very greatly strengthened the dynamic method in the study of light, although the electromagnetic theory of light is not a me-

(*Continued on page 174*)

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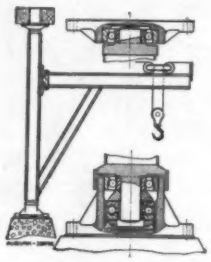

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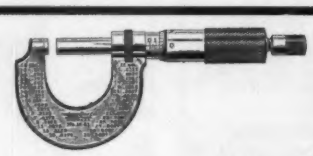

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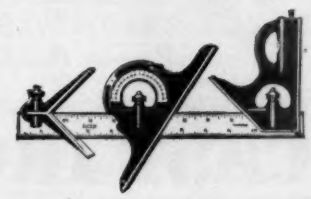

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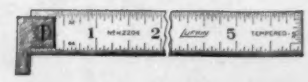

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"NOBODY knows" how tired you are of trying to guess what your fuel costs will be. Only you, yourself, can most appreciate what it would mean to be relieved of this burden.

Gas Fuel will simplify your cost problems. It will give you an exact knowledge of what your fuel cost is today and will be tomorrow. You can reckon to a penny just what the fuel facts of your business are.

Gas Fuel is paid for after it is consumed. Only so much fuel as is actually concentrated on productive work is used. The fuel burned bears an exact relation to its cost because it is all utilized for known results. There is no waste. There is no sub-normal production period. Gas Fuel is 100% efficient.

Gas gives you control of fuel results and keeps fuel cost within control.

All useful fuel must be converted into gas when it is burned. All is wasted which is not gasified. You must tie up valuable space for storage of raw fuel, for the disposal of unburned residue and for necessary operating space.

You must operate a gas-making plant of your own *at a variable cost* dependent on many conditions both inside and outside your plant—some of which you cannot control.

Let us keep the dirt, soot, cinder, ash and smoke at Boston's modern gas-making plant and deliver to your plant through gas mains a clean, efficient ready-to-use fuel

Boston Consolidated Gas Co.

Reaction Turbine

(*Continued from page 147*)

hydraulic condition occur in the high-pressure constructions which would permit the building up of pressure on the top of the turbine runner, the result would be a discharge at the point of shaft entry under high-pressure conditions. As this is to be avoided, a stuffing-box packed with a specially devised graphite-metallic packing has been provided. To prevent generation of excessive heat by the rubbing of this packing against the shaft at the high rotating speed at which the unit runs, it is of course desirable that the packing be kept as loose as possible. To prevent any leakage water from passing the stuffing-box at all under such conditions, a lantern gland is introduced between the packing rings, thus forming a chamber into which any seepage water passing the first rings of the packing may be collected and carried away to tailwater. As a further safeguard, however, a water-operated ejector is furnished to remove any seepage from the guide-vane or shaft stuffing-boxes.

The main steady bearing is of the babbitted and oil-lubricated type, made in halves and supported directly from an extension of the upper ring casing cover. It is arranged for pressure lubrication introduced at the center,

(*Continued on page 170*)

Enameling

(*Continued from page 150*)

be great enough to withstand the impact.

Figures have been obtained on raw materials for enamels, giving their comparative abilities to stretch or withstand the stresses of ore mentioned that cause crazing or chipping. In formulating, then, an enamel must be made that will have good elasticity, so that ordinary stresses will not cause crazing or chipping.

Pin-holes and blisters are nearly always caused by improper cleaning of the metal. Scale or dirt is usually found to be the trouble-maker. Under-firing makes for bubbles through cover coats, all the gases not being expelled when the ground coat is fired. Over-firing volatilizes some of the ground coat, and the iron beneath is oxidized on succeeding burning, causing lifting. Scum on finished ware is usually due to the lack of oxygen in the enamel furnace.

Lead oxide and boric oxide are the only fluxes that can be used in large amounts without starting crystallization. Although borax gives greater strength than lead, it cannot displace it altogether, because its coefficient of expansion is much lower than that of iron, while that of lead oxide is nearly the same. This latter quality, together with its strength-giving qualities, great brilliancy, and unrestricted working-range, make it one of the most valuable, if not the most valuable, of fluxes. As some enamelers express it, no ingredient gives an enamel so much ability to "go around corners" as lead.

Zinc oxide gives greater strength and elasticity to enamels than any other raw material. When zinc is used in large quantities, crystallization sets in. Ten per cent seems to be about the ideal percentage. Its coefficient of expansion is intermediate, which makes it still more useful in compounding. ZnO is sometimes used as an opacifier in mill additions, but this is bad practice, and results in enamels that are poor in gloss and color.

Litharge, PbO, is the most economical lead product for a manufacturer to use. The cost per pound of metallic lead or oxide is considerably lower than either that of red lead or white lead.

Red lead Pb_3O_4 sometimes is preferred on account of the oxidizing effect obtained from the extra oxygen content, but the economy of this is doubtful. Sodium nitrate ordinarily turns the trick. Some manufacturers claim that after seventy-five per cent of the time of fritting is over, no oxidizing effect is obtained from any of the raw materials. At this point

(*Continued on page 170*)

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OKONITE insulation is a rubber compound containing never less than 30% by weight (over 60% by volume) of wild, dry, Up River Fine Para Rubber with no admixture of low grade rubber, reclaimed rubber or rubber substitutes.

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GOOD LIGHTING OF INDUSTRIAL PLANTS SECURES SAFETY AND EFFICIENCY.

The Code of Lighting for factories, mills and other work places of the State of New Jersey makes excellent recommendations of daylight for the proper lighting of industrial buildings.

Adequate daylight facilities through large window areas, together with light, cheerful surroundings, are highly desirable and necessary features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the viewpoint of maximum plant efficiency.

Importance of Daylight.

The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries, by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial apparatus—all go to emphasize the many advantages and economies that result from vital and adequate window space, as a means for daylight in the proper quantities, and in the right direction during those portions of the day when it is available.

Three Considerations.

Three important considerations of any lighting method are sufficiency, continuity and diffusion, with respect to the daylight illumination of interiors. Sufficiency demands adequate window area; continuity requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and supplementing lighting equipment for use on particularly dark days, and especially towards the close of winter days, (c) diffusion demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or matt finish, in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes; but that it may be returned by reflection and thus be used over and over again.

Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain results that will be satisfactory to the human eye.

Requirements for natural lighting:

1. The light should be adequate for each employe.
2. The windows should be so spaced and located that daylight is fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare, due to the sun's rays, and light from the sky shining directly into the eye, or where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

As will be noticed in the above recommendations, large windows and proper diffusion of daylight are urged, in order to meet the demands of daylight lighting.

Shades may be eliminated and most efficient lighting obtained by the use of Factrolite Glass.

If interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

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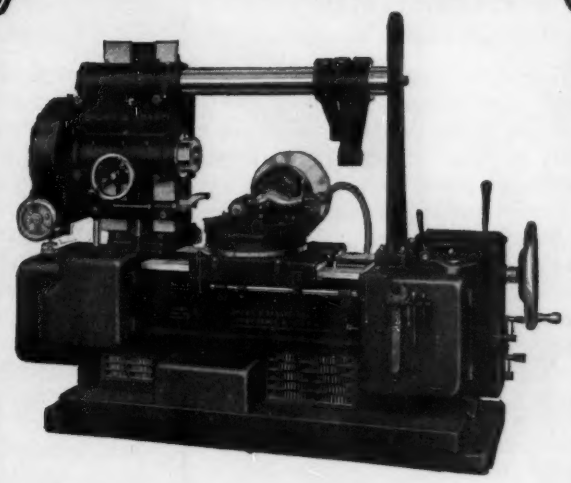
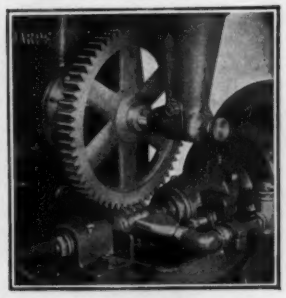


The Differential Eliminates Unnecessary Calculation

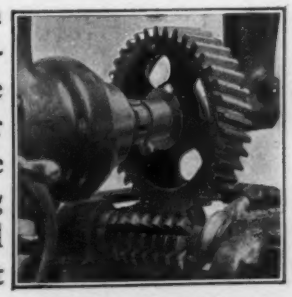
A WINNING feature of the Brown & Sharpe No. 44 Spur and Spiral Gear Hobbing Machine is the differential. With the introduction of this device the selection of change gears, previously a difficult mathematical problem, was greatly simplified. And, the differential is but one of the modern construction features of the No. 44 Machine.



Hobbing a Spur Gear

The Brown & Sharpe No. 34 Spur and No. 44 Spur and Spiral Gear Hobbing Machines are representative of the highest development in machines made for the rapid production of accurate gears.

If you are further interested in the design, operation or production possibilities of these machines, send for "Brown & Sharpe Gear Hobbing Machines," a well illustrated booklet covering both.



Hobbing a Spiral Gear

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

Enameling

(*Continued from page 168*)

oxidizing conditions are maintained through the burners.

It is not likely that lead will ever be entirely excluded from enamel formulas, although some manufacturers have done so with more or less success. They have used more borax and zinc oxide, but have decidedly limited their working-conditions. Leadless enamels do not have the give and take of lead enamels, and slight variations in the base metal will cause serious crazing or chipping trouble.

Selected Grades

Anthracite

and

Bituminous

COAL

BURTON-FURBER
COAL COMPANY
50 CONGRESS STREET
BOSTON

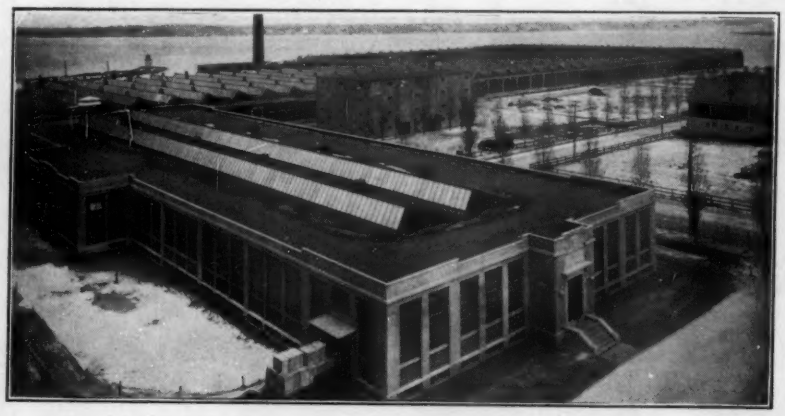
Reaction Turbine Plant

(*Continued from page 168*)

and overflows are provided both top and bottom which return the oil to a sump, whence it is raised to a storage-tank some distance above, means for collecting the oil from the bearing having been carefully worked out so that there is no seepage or disagreeable accumulation of oil outside. A check system of oil grooving is provided in the bearing, each set of grooves being fed from circular channels which are kept constantly filled by the pressure oil. The turbine guide-vanes are made of annealed cast steel and are of the disk type. This form is particularly useful in high-head turbine construction, as, by interposing metal disks between the spindles and the guide-vanes proper, it is possible to secure a very rugged connection between the preferable slender shape of the guide-vane and the necessarily large diameter of the spindles which move it. Were the disks omitted from the guide-vanes, it would be necessary to shape them very differently, making them thick at the center where the spindles attach and seriously affect the hydraulic form. The full width of the guide-vanes for the Oak Grove unit (which, it will be remembered, is of 35,000 h. p. capacity) is but seven inches. Their supporting spindles rotate in grease-lubricated, bronze-bushed bearings. The unbalanced thrust, or upward lifting tendency of the guide-vanes (the ends of the spindles being exposed to the casing pressure) is carried on specially constructed thrust rings, grease lubricated, and made of Parsons metal. The stuffing-boxes through which the guide-vane spindles extend for their connection to the gate-operating mechanism are extra long and are provided with lantern glands and drains to carry off seepage water in the manner previously described in connection with the stuffing-boxes for the main shaft. Outboard bearings support the extreme ends of the guide-vane spindles.

The pressure regulator, or relief valve, provided for the Oak Grove turbine is of particular interest to those more familiar with the types of regulator used on turbines of moderate head, although to users of impulse or Pelton wheels it will not appear very different from the auxiliary relief, needle-regulating nozzle used in connection with the modern Pelton wheel. In the design of the relief valve, it was necessary to provide a construction which would have characteristics of discharge in agreement with the flow of the water through the turbine guide-vanes, since, if a change of quantity flow through the turbine was not met with the relief of an equal quantity through the relief valve during the periods of speed regulation, a difference in velocity in penstock flow would result. Under high-head conditions, the danger from variations of penstock velocity may easily be more serious than with turbines operating under ordinary heads. It was also necessary to secure a smoothness of operation and a freedom from vibration in the relief-valve discharge, as the high-head conditions would easily make disturbances of this sort a serious menace. The disposal of the jet discharging from the relief valve, and the effective quenching of its energy, is ordinarily for high-head Pelton-wheel installations. In the present case, however, the jet is turned through an arc slightly in excess of 90 degrees by means of a substantial cast-iron elbow, and is allowed to discharge directly into the stream below the power-house in a spectacular but harmless fashion without disturbing the draft-tube tail-water.

Acknowledgments are made to Mr. C. P. Dunn, Designing Engineer of the Portland Electric Power Company, and to Mr. R. C. Smith, of the Pelton Water Wheel Company, for data and illustrations for this work.



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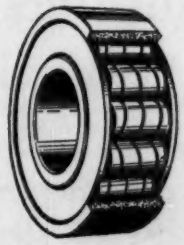
BUT not even he could have foreseen the great industrial development of this country which would come about through improved methods of manufacture and transportation, and the important part that would be played by Hyatt roller bearings.

Modern industry requires and far sighted engineers demand that rotating parts be mounted on bearings that will roll instead of rub.



Raw silk, wool and cotton are transformed into the fruit of the loom; deeply hidden coal and metal ores are brought to the light; ribs of steel are fabricated for the backbone of modern construction. In fact every phase of industry is speeded up and assured uninterrupted output by the use of Hyatt roller bearings which, with their rugged durability and unfailing dependability are serving the needs of the nation faithfully and well.

When designing or purchasing mechanical equipment, remember that the combined experience of the Hyatt Roller Bearing Company's engineers and specialists is always at your disposal to help you solve your bearing problems.

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HYATT ROLLER BEARING COMPANY, NEWARK, N. J.

Launching of the U. S. S. Lexington

(*Continued from page 148*)

chain used was 1400 tons, or over 3,000,000 pounds. The chain piles were laid in the form of the letter U, and as the ship moved down the ways, each pair of drags turned over end to end, and came into action successively, thus acting as a steadily increasing resistance. The idea of arranging the piles in U-shaped form, turning them over, and bringing them into action successively, was adopted so as to prevent any undue shock coming upon the ship or upon the wire ropes.

The resistance offered by a pile of chain cable is very great, especially if it digs into the ground at all; and furthermore, being very flexible in character, the pile moves over the ground much more evenly than would an anchor or a heavy armor plate. Consequently, the pull exerted upon the *Lexington* by the system of chain drags used in her launching was remarkably free from shocks and fluctuations.

To still further aid in checking the ship, a mask was built at the after end of the cradle, and the four propellers were prevented from turning, and, as already stated, the ship was stopped with the bow less than 140 feet from the end of the ways. The last pair of chain drags was not moved at all, and the next to the last pair only slightly, showing the complete effectiveness of the whole system of checking the vessel.

Every possible means was taken to ensure the safety of the ship and of the people attending the launching. One important precaution was the placing of the observation stand at the side of the ship instead of at the bow, as is customary in most launchings. This was done so that in the event of the breaking of any of the wire ropes attaching the chain drags to the ship no harm could come to anyone. This and many other precautions show the great amount of consideration given to the problem, and the builders of the *Lexington* are certainly to be congratulated upon the success attending every feature of the launching.

Dr. Davey Finds Method of Increasing the Conductivity of Copper. "Large crystals," the announcement states, "grow in such a direction that the atoms are arranged in columns along the length of the crystal. It is this regular arrangement of the atoms which, it is believed, gives to the single crystals their superior conductivity when compared with ordinary copper in which the crystals are small and the arrangement of these small crystals quite chaotic.

"There is reason to believe that the conductivity of copper crystals along another axis from that measured may be even 60 per cent greater than the value of pure copper, but the growth of single crystals along this other axis has not yet been brought under control."

By means of mathematical calculations, Dr. Davey found that copper composed of a single crystal should have a conductivity 14 per cent higher than that of ordinary copper. These calculations were based upon the arrangement of the copper atoms as revealed by the use of the X-ray.

It is evident that this method of increasing the electrical conductivity of copper is of only theoretical interest at the present time, but it is entirely possible that continued experimentation may open the way to commercial practicability.

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THE EXPLOSIVES ENGINEER
WILMINGTON DELAWARE

The November Issue

Truly amazing figures are revealed in the November issue by Daniel Harrington, eminent Consulting Engineer of Salt Lake, in his article "Coal Mine Blasting from the Surface", which describes the system of firing shots after all men are out of the mine. No student of coal blasting problems should miss this story.

Other articles which contain practical, usable information are "The Zinc Mines of Mascot"; "Channeling with Hammer Drills and Rock Dusting Equipment at Dawson, New Mexico".

Otho M. Graves, President, National Crushed Stone Association, tells what that organization's recently established Engineering Bureau will mean to the crushed stone industry, and there is an inspiring short biography of Howard I. Young.

Regular features of every issue include the popular Blaster Bill and Wilyum Jan cartoons, and an index of the month's books, articles and patents on drilling, blasting and allied subjects.

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A Survey of Physics

(*Continued from page 166*)

chanical or dynamic theory in the older narrow meaning of these terms, and the altered points of view which have come from the principle of relativity have strengthened the method of dynamics.

Profound changes in our so-called fundamental ideas in physics have come about in recent years because of two things, namely: (a) an increasingly clear appreciation of the significance of irreversible actions in nature has led us to recognize definite limitations to the method of mechanics (Planck's dynamics), for an irreversible process is beyond the range of the mechanical method; and (b) the principle of relativity has modified our ideas of time and space and has extended the idea of energy to include the idea of mass; but these changes in our so-called fundamental ideas seem to be merely formal, or at most these changes seem to have eliminated only what is non-essential from our fundamental ideas, leaving our methods essentially unaltered; but the quantum hypothesis seems to strike more deeply.

The quantum hypothesis denies the principle of continuity as used throughout the method of mechanics. Atomic processes take place by jumps, so that the idea of time as a continuous flux is brought into question; and if time as a continuous flux is objectively non-existent, then the whole structure of theoretical dynamics must be purely idealistic, and at best only applicable to large-scale phenomena. Indeed, the atomic theory itself raises the presumption that continuous space is an idea, not a physical fact, and thus the purely idealistic character of theoretical dynamics is again indicated.

The whole of statistical mechanics, which includes the kinetic theory of gases, is a theoretical structure based upon purely mechanical postulates concerning atomic action, whereas the quantum hypothesis rules out the purely mechanical conceptions of atomic action, and it seems, therefore, that the quantum hypothesis is likely to lead to profound changes in the atomic method.

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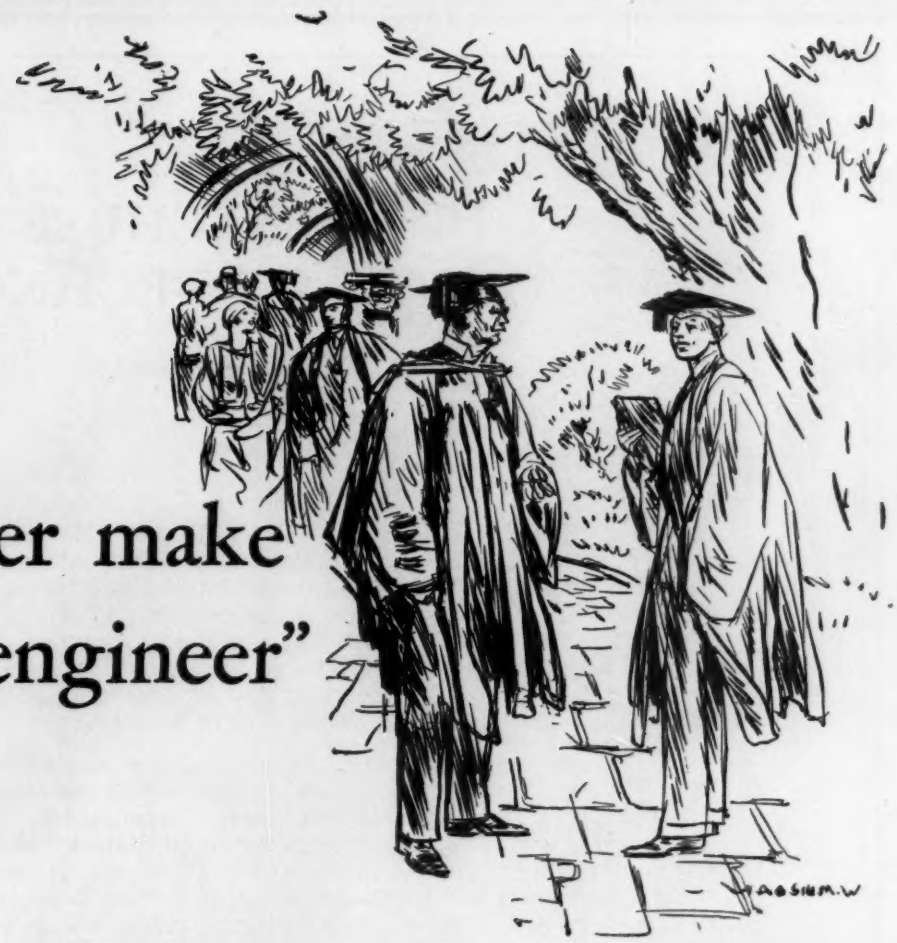

"You'll never make an electrical engineer"

Carl Taylor

SO a blond young man named Taylor, just graduating in electrical engineering at the University of North Carolina, was advised by a conscientious professor. The professor's conviction was based on quiz papers and was amply justified. But the young man was not discouraged; he had other hopes, he said. Today—ten years later—he occupies a peculiarly important position with the Westinghouse Company.

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A Lesson in Psychology

AN OLD CHIEF of the Pueblo Indians, on his first visit to Chicago, was taken to the top of the new Tribune Tower Building. On leaving the elevator, he turned to his guide and asked, "When are we going up?" When he was told that he was already on the top floor, the old man declared flatly that he did not believe it, because he had climbed no ladders;—nor could he be persuaded until he looked over the city spread out beneath him.

It's all a matter of association. The Chief had always associated the idea of "going up" with the ladders of a Pueblo. In a similar fashion, to people in modern cities the world over, the idea of ascent is inextricably bound up with the name of Otis.

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